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Examiners' Report
June 2022

International GCSE Science (Single Award) 4SS0 1P

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Introduction

This was the second summer series Physics examination for the International GCSE Single Award Science qualification. Questions were set to assess candidates' knowledge, understanding and application of Physics from all eight topics in the specification. This year, candidates and centres were issued an advance information document, which gave information about which sub-topics of the specification would form the main focus of the examination. In addition, candidates were provided with a full formulae sheet for the examination, which removed the requirement to recall any of the formulae.

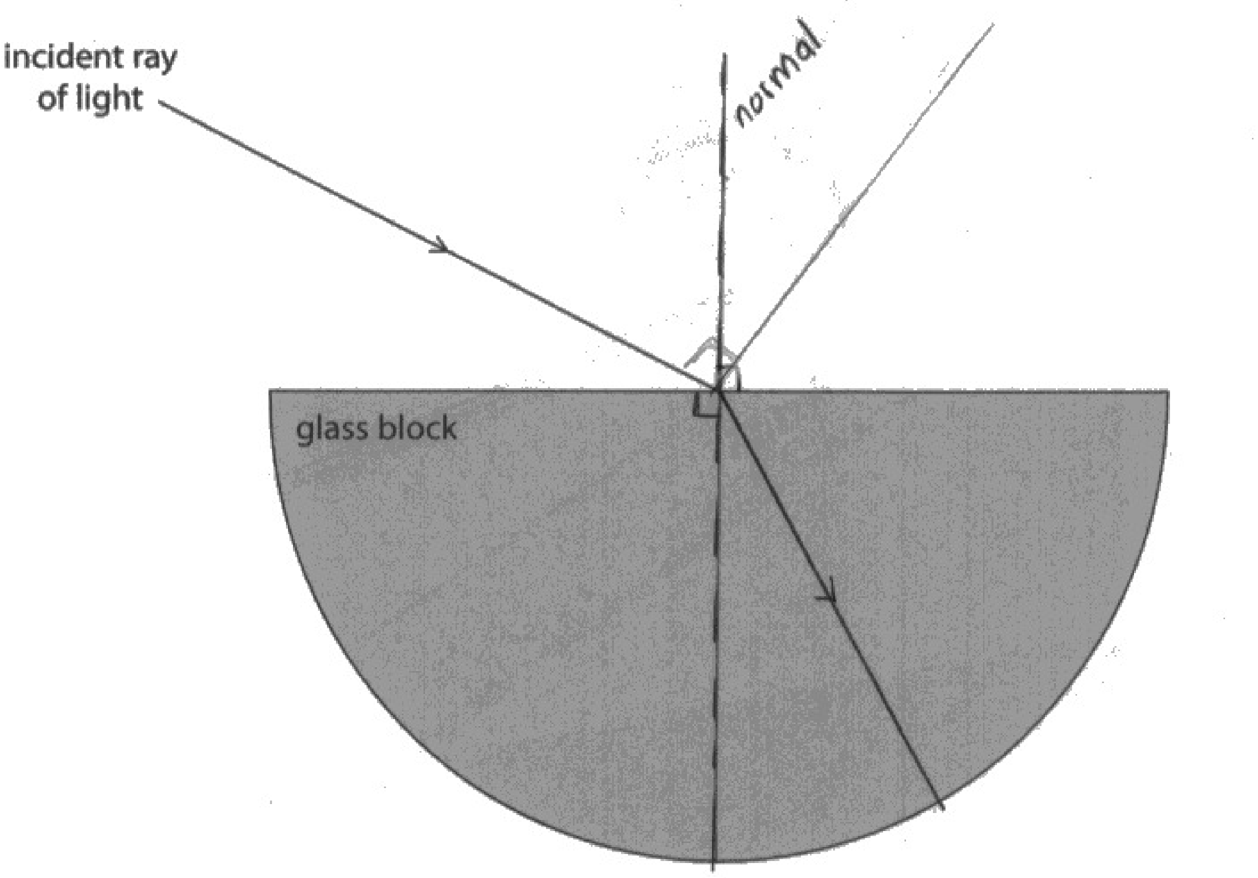
The examination was written to assess across the full range of grades from 1 to 9. Consequently, some questions were written to be challenging whilst others were designed to be more straightforward and accessible. A range of different question types were included in the examination such as objective and multiple choice, calculations and both short and long written responses. Approximately 20% of the marks available in the examination were for candidates' demonstration of experimental skills and understanding.

Successful candidates were well-acquainted with the content of the specification and could recall facts whilst applying their understanding to new and complex situations. They were competent in performing quantitative work and could rearrange formulae to obtain the correct answer. Successful candidates also showed evidence of undertaking all the required practicals themselves and could produce detailed, coherent methods whilst recalling the relevant results of these experiments.

Less successful candidates showed gaps in their knowledge of topics and either had limited experience or could not recall information from the required practical tasks. These candidates often did not address the demands of the question and overlooked the importance of the command words being used.

Question 2 (a)

Many candidates answered Q2(a) correctly, displaying an excellent understanding of ray diagrams. Some candidates confused the ideas of reflection and refraction, which resulted in only the mark for drawing the normal line being accessible. More able candidates correctly differentiated between reflection and refraction, but did not draw their diagrams accurately enough to convey the idea that the angle of incidence and angle of reflection should be equal.



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Examiner Comments

This candidate is awarded the mark for correctly drawing the normal in Q2(a)(i) and also the marks for their refracted ray in Q2(a)(ii). However, only 1 mark is awarded in Q2(a)(iii) for their reflected ray since the angle of incidence and angle of reflection are not equal.

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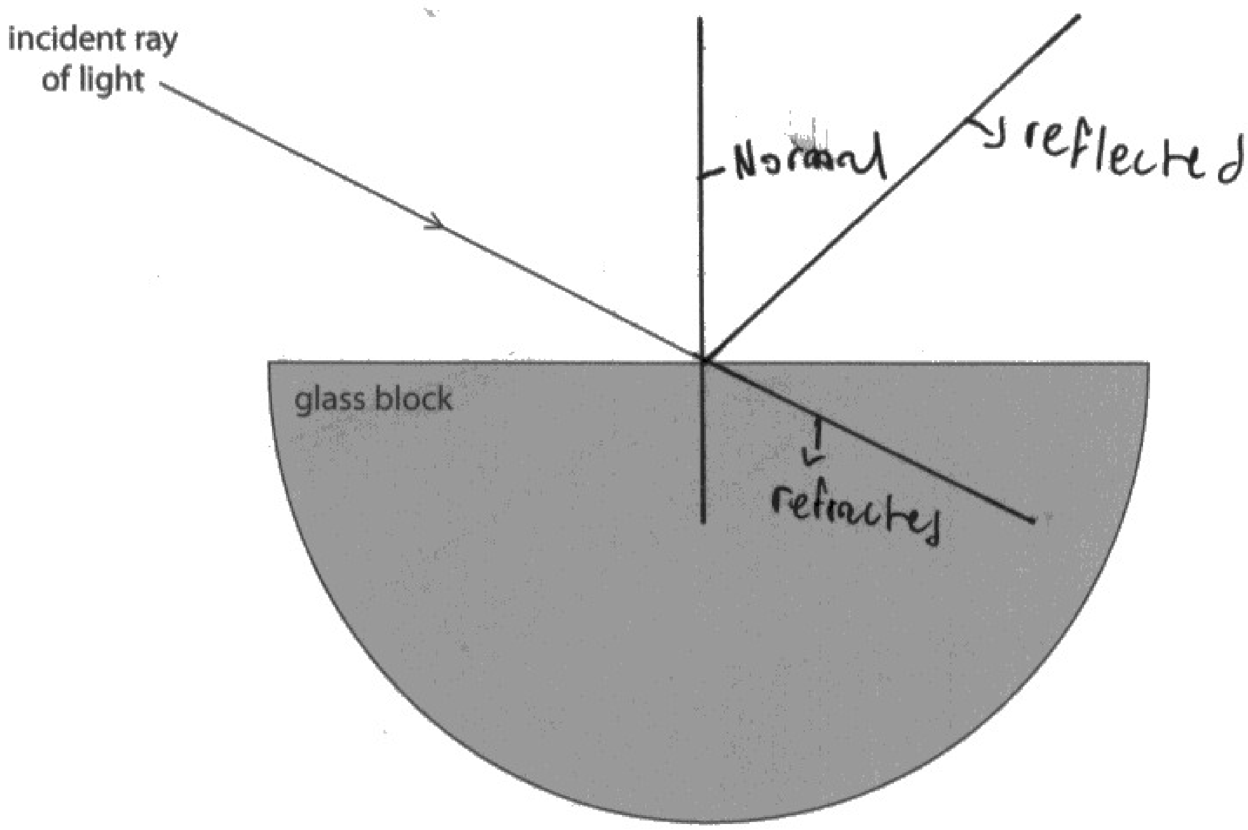
Examiner Tip

Always use rulers when drawing ray diagrams and take care with angles. Use a protractor to check that the angles are correct.



ResultsPlus Examiner Comments

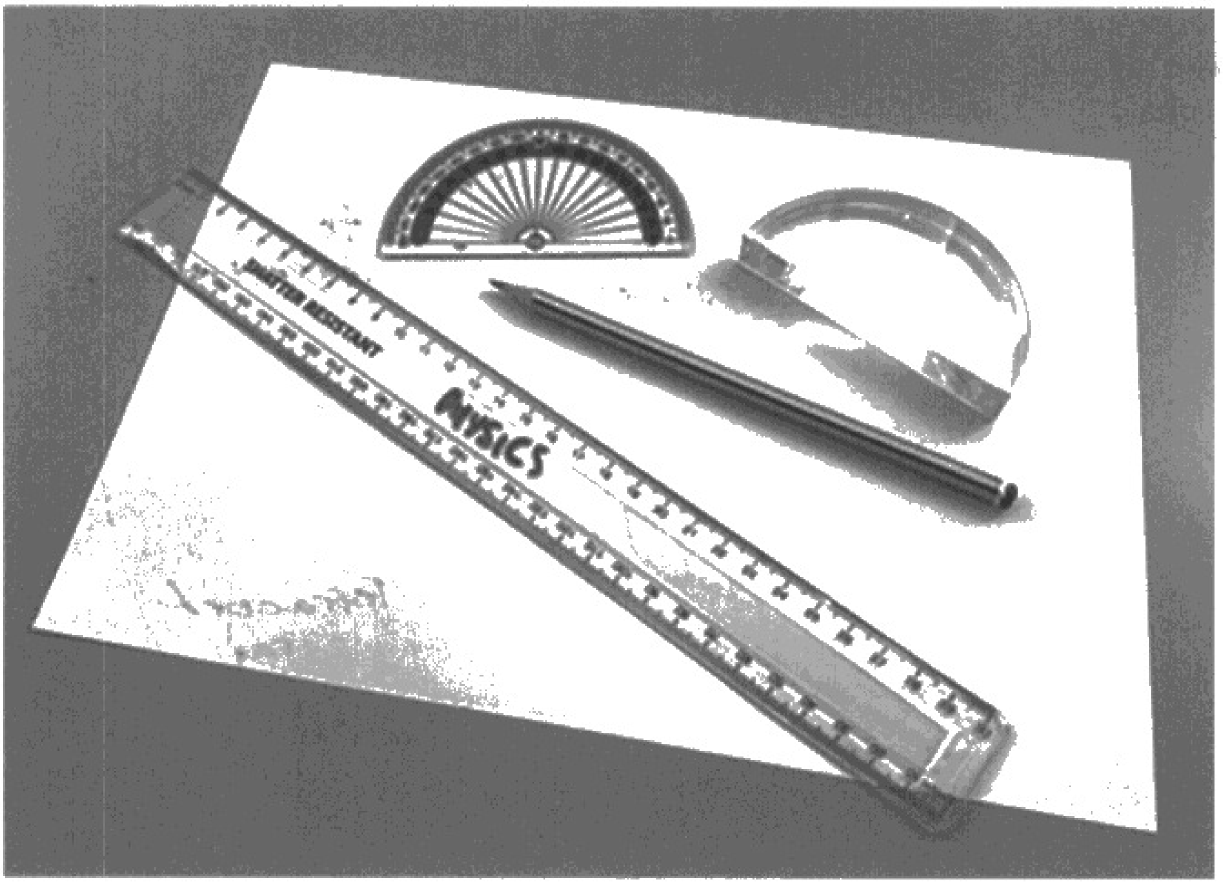
This candidate is also awarded the mark for drawing the normal line. However, their refracted ray in Q2(a)(ii) shows no deviation from the incident ray and, therefore, is only awarded 1 mark. The reflected ray in Q2(a)(iii) is on the limit of acceptability and is awarded both marks, despite the angles not being perfectly equal.

Question 2 (b)

There were some excellent answers to Q2(b) and candidates had clearly revised the method of this experiment due to its named inclusion in the advance information. Most candidates opted for the common method of marking the incident and emerging positions of ray of light before joining the points together with a ruler after removing the glass block. The best answers also described measuring both the angles of incidence and refraction with a protractor. Many candidates did not name a suitable light source (eg a ray box or laser), however some showed this in their included diagram. Most candidates who included a diagram in their response were awarded at least 1 mark for it.

As expected, this question discriminated well at several grade boundaries.

(b) A student investigates the refraction of light by the semi-circular glass block using the equipment in the photograph.



Design an experiment to investigate how the angle of incidence of a ray of light affects the angle of refraction in the glass block.

You may draw a diagram to help your answer.

you place a light Source and one side of a piece of white paper and you draw a line where the semi-circular block is. Then you turn the light box on and aim a beam towards the glass block. After you draw the line of incident which is the light beam and then a line from where the light ends on the other side of the glass block. Then you measure everything out.

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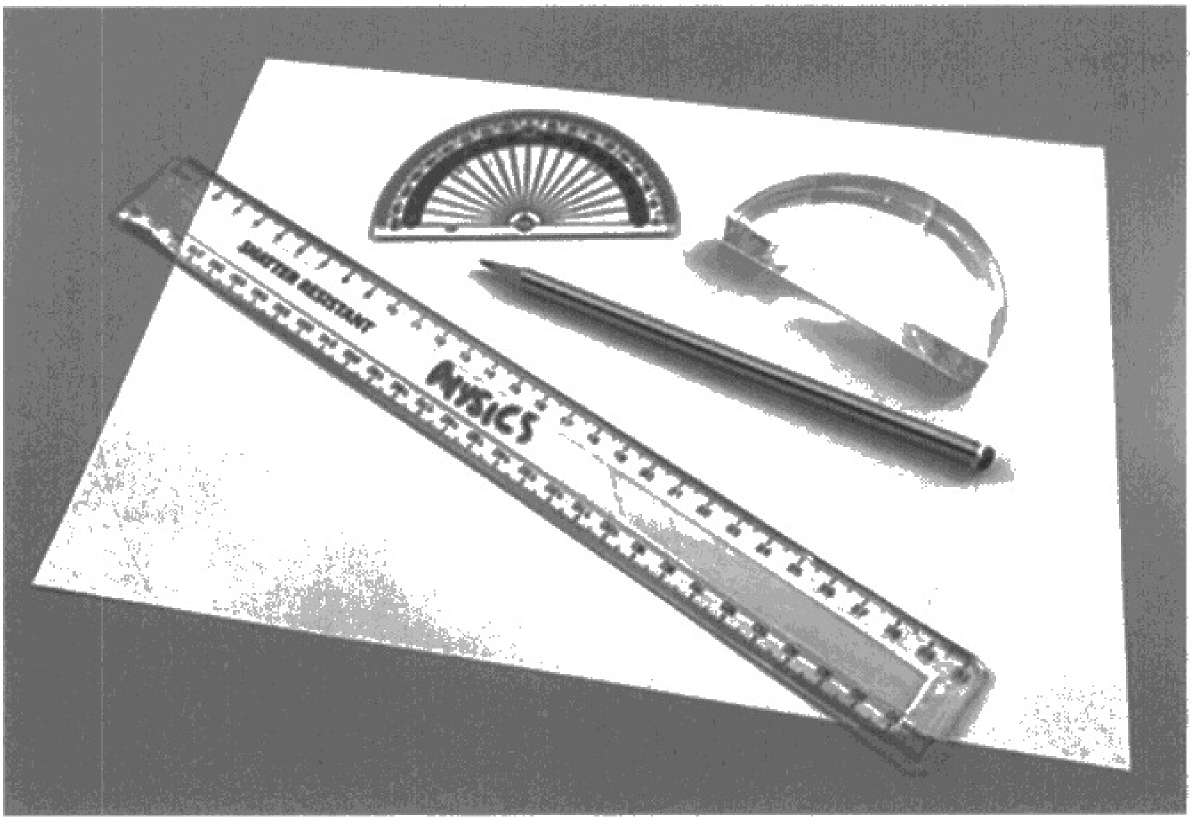
Examiner Comments

This response scored 2 marks. The candidate has not included a diagram in their response and the "light source" is too vague to be awarded. However, this light source is later named as a light box, which is acceptable and gains MP1. The candidate is also awarded MP2 for the clear idea of drawing around the block. Beyond this, the candidate's answer is too vague to gain further credit. Had they been more specific about the marking of the incident and refracted rays then MP3 and MP6 could have been awarded.

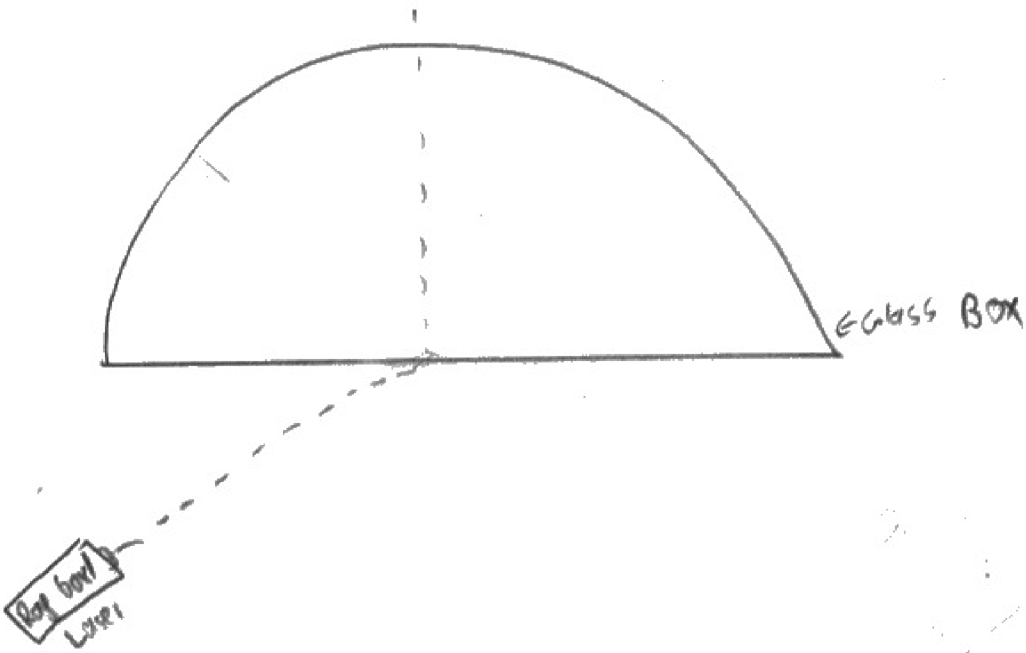
(b) A student investigates the refraction of light by the semi-circular glass block using the equipment in the photograph.



Design an experiment to investigate how the angle of incidence of a ray of light affects the angle of refraction in the glass block.

You may draw a diagram to help your answer.

(6)



Firstly, we need to set up the experiment as shown in the diagram above the piece of paper. Next you need to turn on the ray box whilst it is in a marked position. Afterwards, observe the light ray that is refracted, mark it with the pencil and draw the line with a ruler. Next, move the ray box 5° to the right and repeat this process. When this experiment continues, the critical angle will be reached and you will have to draw a line along the boundary of the glass block. Make sure you use the same ray box and turn off the background lights so that the light ray is more visible in order to increase the accuracy of the experiment. Then, conduct this experiment at least twice more to get reliable results in order to come up with a proper conclusion.

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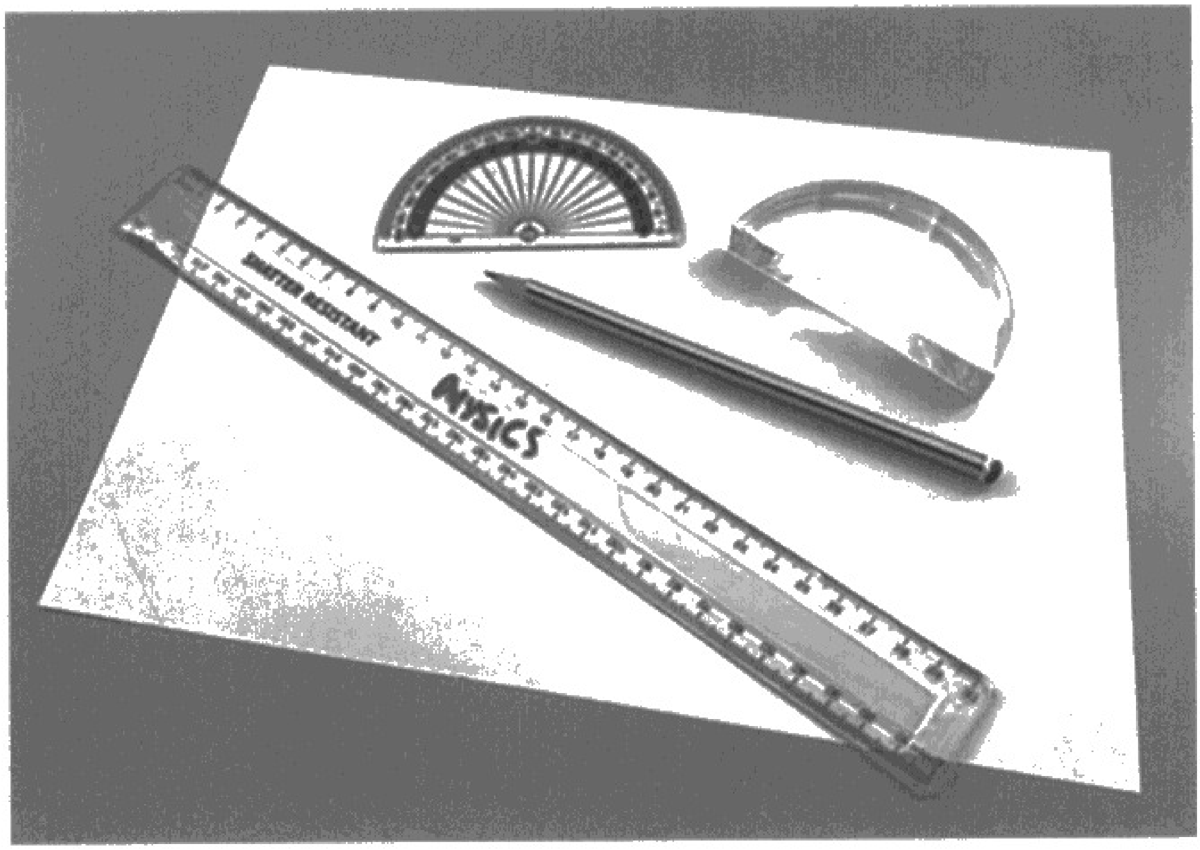
Examiner Comments

This response scored 4 marks. The candidate's diagram and written response clearly shows the use of a ray box, which gains MP1. In addition, there is a good description of marking the position of the refracted ray and then drawing the line with a ruler, which gains MP6 and MP7. The candidate is also awarded MP9 for the idea of repeating the process for different angles of incidence. To improve their answer further, this candidate should have described how the angles of incidence and refraction could have been measured.

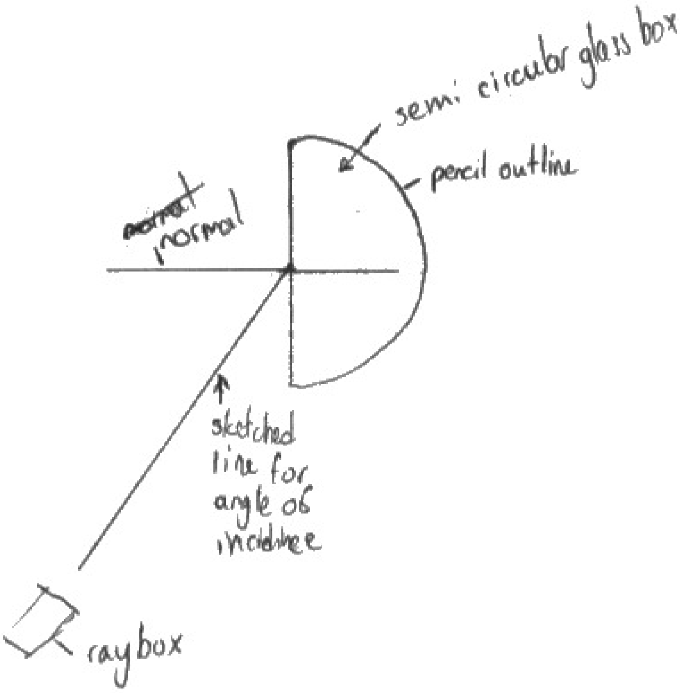
(b) A student investigates the refraction of light by the semi-circular glass block using the equipment in the photograph.



Design an experiment to investigate how the angle of incidence of a ray of light affects the angle of refraction in the glass block.

You may draw a diagram to help your answer.

(6)



First drawn a pencil outline of the glass block to ensure its location remains the same. Then from ~~?~~ the ~~center point~~ normal line measure using the protractor the ~~predetermined~~ angle at which the ~~a~~ ray on incidence is to be. ~~?~~ Mark the angle of incidence with a pencil line and ruler ~~to~~ for reference. Then using a ray box or another source of a light ~~ray~~ ray line up the light ray with the previously marked line of incidence. Once this is done you will notice the light refracting within the prism. Measure this in accordance to the normal via to protractor and note down results. Then repeat this experiment more times with different angles of incidence. If need ~~to~~ you can plot this data on a graph.

ResultsPlus Examiner Comments

This response scored 6 marks. The candidate has made good use of the opportunity to draw a diagram and scores both MP1 and MP3 for the named ray box and clear drawing of the normal where the ray meets the block. Although concise, the candidate's response gains MP2 (for drawing round the block) and MP4 and MP5 (for measuring the angle of incidence with a protractor). Finally, the candidate gains MP6 (for measuring the angle of incidence), MP9 (for repeating for different angles of incidence) and MP10 (for plotting a graph of the results). This is an excellent answer – every sentence is clear and focused.

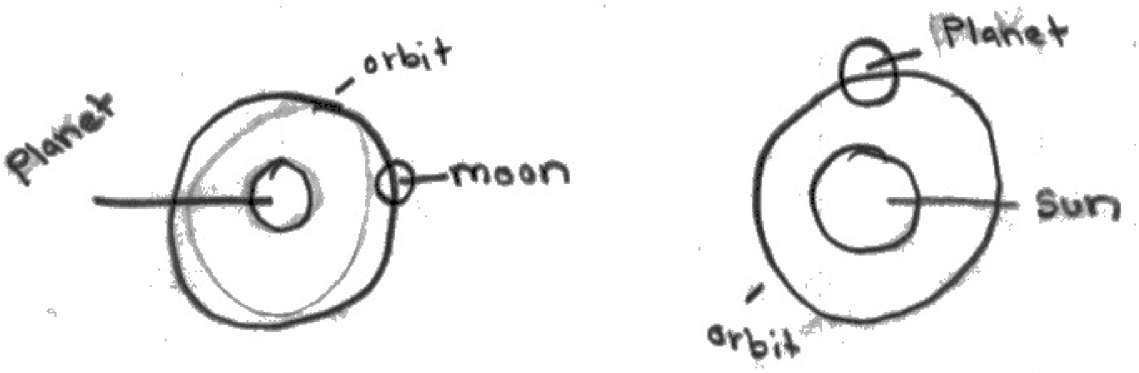
Question 3 (a)

Q3(a) is another question that highlights the advantage that can be gained from drawing a diagram. This often allowed candidates to score marks from ideas that weren't communicated in the written part of their response. The key similarity of having an approximately circular orbit was often seen in candidates' diagrams. When drawing diagrams for questions about orbits, candidates are advised to draw them in plan view and ensure objects are labelled.

3 (a) Give a similarity and a difference between the orbit of a planet and the orbit of a moon.

You may draw a diagram to support your answer.

(2)



similarity

Both the moon and Planet ~~to~~ do circular orbits.

difference

The moon orbits the Planets and the planet orbits the sun.

ResultsPlus
Examiner Comments

The diagram alone is sufficient for both marks to be awarded. Both orbits are approximately circular and the planet, moon and star are all clearly labelled. The candidate reinforces the communication of their understanding with the written part of their response, which also would have scored both marks.

ResultsPlus
Examiner Tip

When drawing diagrams for questions about orbits, draw them in plan view and ensure objects are labelled.

Question 3 (b)(i)

The vast majority of responses seen to in Q3(b)(i) were irrelevant and did not score the mark. Incorrect responses included:

- Easier to see the difference and compare orbital speeds.
- Easier to read and understand.
- Easier to spot the planet with the highest/lowest speed.
- Presents the data accurately and precisely.
- Shows each planet has its own different speed.

The strongest candidates were able to identify which variable/axis was non-continuous.

Question 3 (b)(ii)

Q3(b)(ii) assessed a candidate's ability to read data from a graph and also evaluate ratio between two values. Most candidates correctly read the orbital speed of Jupiter and were awarded the first mark. However, reading the orbital speed of Uranus proved more challenging and some candidates did not progress further due to an error in doing this. For full marks, candidates were expected to evaluate the ratio the correct way round, with either one of the values scaled to 1 or with both values as whole numbers. Most candidates only scored 2 marks for not meeting one or both of these criteria.

(ii) Using information from the bar chart, determine the ratio of the orbital speed of Jupiter to the orbital speed of Uranus.

(3)

Jupiter = 13 km/s

Uranus = 6 Km/s   + = 19 ÷ 2

ratio = ~~4~~ 9.5

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Examiner Comments

This candidate has read the value for Jupiter correctly from the graph, but the value for Uranus is outside the allowed range. This limits the number of marks awarded to 1 mark.

(ii) Using information from the bar chart, determine the ratio of the orbital speed of Jupiter to the orbital speed of Uranus.

(3)

orbital speed of jupiter = 13 km/s
orbital speed of uranus = 6.8 km/s

~~jupiter :~~ uranus : Jupiter
6.8 : 13
1 : 1.9

ratio = 1 : 1.9

ResultsPlus
Examiner Comments

Both values have been correctly read from the graph and a ratio calculation has been attempted. Although both values have been scaled such that the value for Uranus is 1, the ratio is presented the wrong way round and so only scores 2 marks.

Question 3 (b)(iii)

Many candidates correctly identified that the Earth was the closest planet to the Sun from the planets presented and that this was the reason for it having the fastest orbital speed. Aside from responses that presented incorrect ideas, some candidates were not awarded the mark as they were not precise enough in their choice of language. For example, stating that Earth was "closer to the Sun" did not score the mark without a further element to the comparison eg "than the other planets".

Question 4 (a)

Candidates found the linked calculations in Q4(a) challenging. Although most correctly wrote the formula in Q4(a)(i), more than half of all candidates did not substitute a value for g in the calculation in Q4(a)(ii) and scored no marks. Many candidates thought they had to calculate the kinetic energy in Q4(a)(iii), rather than using the idea of conservation energy. These candidates usually scored no marks in Q4(a)(iv).

The metal ball has a mass of 0.52 kg and is held at a height of 0.82 m above the floor.

(i) State the formula linking gravitational potential energy (GPE), mass, *g* and height.

(1)

gravitational potential energy (GPE) = mass (m) × gravitational field strength (g) × height (h)

~~GPE ×~~ GPE = m × g × h

(ii) Calculate the decrease in the metal ball's GPE store when the ball falls to the floor from this height.

(2)

GPE = 0.52 × 10 × 0.82
= 4.264

decrease in GPE store = 4.264 J

(iii) State the amount of energy in the metal ball's kinetic store just before it hits the floor.

Ignore the effects of air resistance.

KE = ½ × m × v²

(1)

KE = ½ × 0.52 × 4.264 = 1.109

energy in kinetic store = 1.109 J

ResultsPlus
Examiner Comments

This candidate scores full marks in Q4(a)(i) and Q4(a)(ii) but no marks beyond this. Their incorrect use of the kinetic energy formula in Q4(a)(iii) is not credited in Q4(a)(iv).

The metal ball has a mass of 0.52 kg and is held at a height of 0.82 m above the floor.

(i) State the formula linking gravitational potential energy (GPE), mass, *g* and height.

(1)

GPE = mass x g x height

(ii) Calculate the decrease in the metal ball's GPE store when the ball falls to the floor from this height.

(2)

GPE = 0.52 x 10 x 0.82

= 4.264 J

decrease = ~~0~~ 4.264

GPE at height = 4.264

GPE at floor = 0

decrease in GPE store = 4.264 J

(iii) State the amount of energy in the metal ball's kinetic store just before it hits the floor.

Ignore the effects of air resistance.

(1)

energy in kinetic store = 4.264 J

(iv) Calculate the speed of the metal ball just before it hits the floor.

(4)

kinetic energy = m v² x 1/2

(kinetic energy x2) / mass = v²

(4.264 x 2) / 0.52 = v²

√16.4 = v

4.045 = v

speed = 4.05 m/s

ResultsPlus
Examiner Comments

This candidate scores full marks in all aspects of this question. Their working is clearly laid out and easy to follow.

ResultsPlus
Examiner Tip

Always include evidence of your working in calculations. Structure your working with a new line for each step so that the examiner can easily see evidence of correct substitutions of data and rearrangements of formulae.

Question 4 (b)

Despite the clear instruction to use ideas about energy, very few candidates scored more than 1 mark in Q4(b) due to only describing differences in the material properties of oil and air. The idea of oil being thicker or more dense than air was common and, in some responses, this was correctly linked to the idea of the drag force in oil being more significant than that in air. Only the most able candidates went further by discussing ideas about energy. Usually, this involved a mark being scored for either recognising that kinetic energy in oil would be less or that energy was lost to a thermal store.

(b) The metal ball is dropped from rest again from the same height above the floor, as shown in diagram 2.

The metal ball now falls through a cylinder containing oil rather than the air.

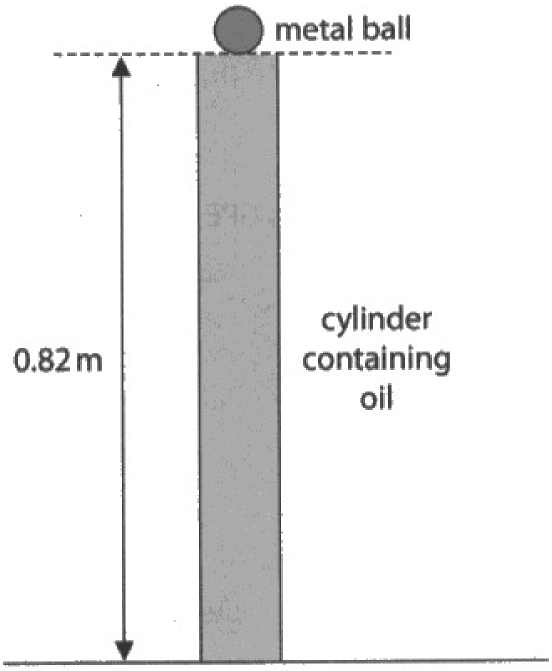

Diagram 2

The speed of the ball just before it hits the floor when moving in oil is less than the speed of the ball just before it hits the floor when moving in air.

Explain, using ideas about energy, the difference in speeds.

(3)

Oil is thicker meaning it will take longer for the metal ball to hit the floor. Where the oil is thicker, it slows down the speed of the ball hitting the floor compared to in air it will be quicker.

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Examiner Comments

This response scores 1 mark for MP1 – oil is thicker. The candidate has ignored the instruction to use ideas about energy.

ResultsPlus
Examiner Tip

Read questions carefully. If a question instructs you to use ideas about energy, it is likely that this will be essential to score full marks in the question.

(b) The metal ball is dropped from rest again from the same height above the floor, as shown in diagram 2.

The metal ball now falls through a cylinder containing oil rather than the air.

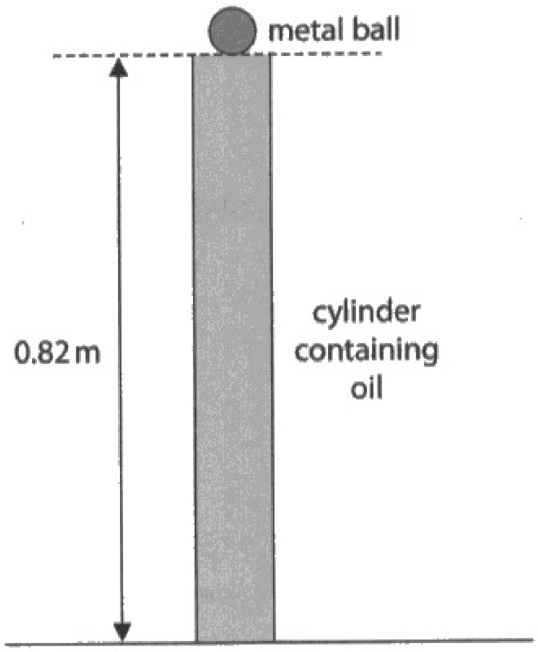

Diagram 2

The speed of the ball just before it hits the floor when moving in oil is less than the speed of the ball just before it hits the floor when moving in air.

Explain, using ideas about energy, the difference in speeds.

(3)

~~This is because there is less air~~ The speed in the oil is less than the speed in the air because there is more drag force in the oil. When the ball falls ~~throw~~ down the cylinder of oil, drag force being a frictional force, opposes the motion of the ball. Its kinetic energy is converted into heat energy because of drag. So this means there is less kinetic energy in the ball just before it hits the floor in the oil, than in the air. Since there is less kinetic energy the balls speed decreases.

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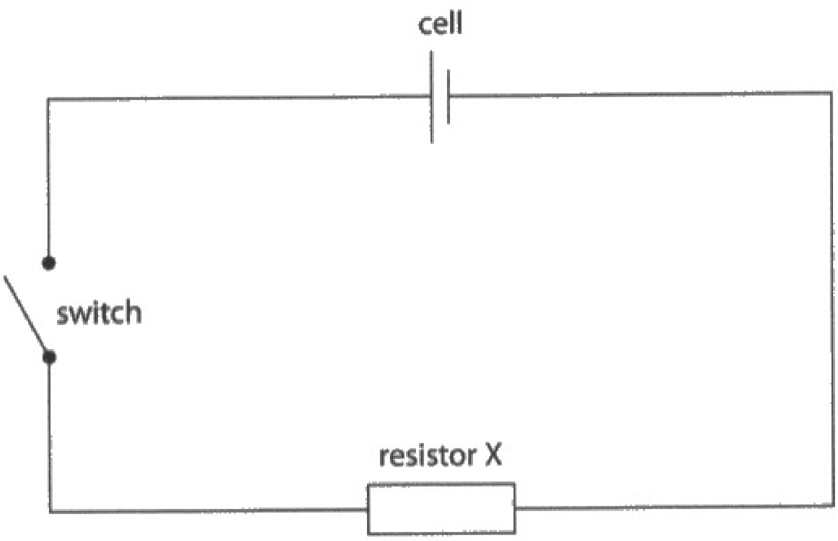
Examiner Comments

Responses like this were very uncommon, but this candidate scored full marks in this question. The candidate is awarded MP2 for recognising that drag is greater than before (in air). They have then fully met the demands of the question by correctly referring to both kinetic energy and thermal energy.

Question 5 (a)

Q5(a) required candidates to **describe** how another component could be added to the circuit to show the presence of a current. Although most candidates selected an appropriate component (usually an ammeter or a lamp), most did not show or describe how it should be connected in the circuit and therefore, only scored 1 mark. Some candidates scored both marks by adding to the diagram in the question.

5 The circuit diagram shows a resistor connected in series with a cell and a switch.



There is an electric current in the circuit when the switch is closed.

(a) Describe how another component could be added to the circuit to show that there is a current in resistor X when the switch is closed.

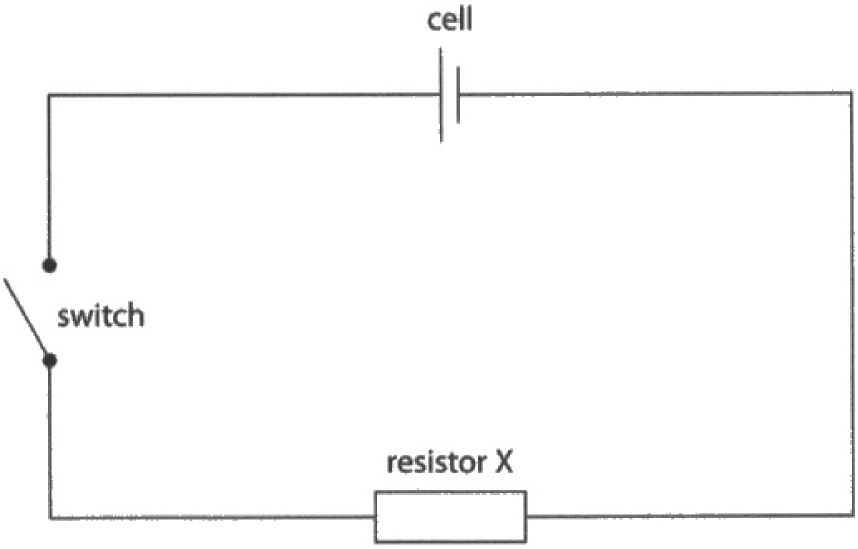
(2)

You could use an ammeter and ~~place~~ connect it in series with the resistor. This ammeter would measure the current value

ResultsPlus
Examiner Comments

This response clearly states that an ammeter should be used and also describes carefully how it should be connected in the circuit. It scores both marks.

5 The circuit diagram shows a resistor connected in series with a cell and a switch.



There is an electric current in the circuit when the switch is closed.

(a) Describe how another component could be added to the circuit to show that there is a current in resistor X when the switch is closed.

(2)

you could add an ammetre to show how moch current is in resistor X

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Examiner Comments

This response does not clearly explain how the ammeter should be connected in the circuit. Only the first marking point is awarded.

Question 5 (b)(i)

Most candidates knew that electrons are the charged particles that flow in an electric current.

Question 5 (b)(ii)

Most candidates were able to score at least 2 marks in Q5(b)(ii) by multiplying the given current and time together. However, very few correctly dealt with the current being given in mA and even fewer knew to divide the total charge by the charge of an electron. Some candidates knew how to complete the calculation but struggled when dividing by a number given in standard form. This showed that they were not comfortable when using their calculators.

(ii) When the switch is closed, the current in the cell is 160 mA.

Calculate the number of charged particles that pass through the cell in 25 s.

[charge transferred = current × time taken]

(4)

160 × 25 = 4000

number of charged particles = 4000

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Examiner Comments

This was the most common response. It is unclear whether the candidate knows that charge is given by current multiplied by time or if they have simply multiplied the two given numbers together. However, benefit of the doubt (BOD) was given and 2 marks were awarded.

(ii) When the switch is closed, the current in the cell is 160 mA.

Calculate the number of charged particles that pass through the cell in 25 s.

[charge transferred = current × time taken]

(4)

$Q = I \times t$

$= 160 \times 10^{6} \times 25$

$= 4 \times 10^{9}$, coulomb.

no. of charged particles $= \dfrac{4 \times 10^{9}}{1.6 \times 10^{-19}}$

$= 2.5 \times 10^{28}$ //

number of charged particles = 2.5×10^{28}

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Examiner Comments

An excellent response that gains full marks. This candidate has clearly set out their working, so it is easy to follow. Both the conversion from mA to A and the use of numbers in standard form have been processed correctly.

Question 5 (b)(iii)

Many responses to Q5(b)(iii) were very brief and did not merit the 3 marks available. A surprising number of candidates thought that the number of charged particles would increase despite the resistance increasing. Most candidates who recognised that the number of charged particles would decrease also scored a mark for stating that the current would decrease. Very few candidates got more than 2 marks in this question.

(iii) Resistor X in the circuit is replaced by resistor Y.

Resistor Y has a higher resistance than resistor X.

Explain how the number of charged particles passing through the cell each second changes when resistor X is replaced by resistor Y.

(3)

$V = IR$. So here the voltage remains constant. So when resistance increases the current will decrease. $I = \frac{V}{R}$. So when current decreases the number of charged particles will also decrease. This is because charge transferred = current x time.

ResultsPlus
Examiner Comments

An excellent response that scores full marks.

(iii) Resistor X in the circuit is replaced by resistor Y.

Resistor Y has a higher resistance than resistor X.

Explain how the number of charged particles passing through the cell each second changes when resistor X is replaced by resistor Y.

(3)

A higher resistance means lower current would pass through the cell. Since ~~Resistor~~ resistor Y has a higher resistance, it would reduce the current along with the number of charged particles that pass through the cell, with equation Q = I × t.

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Examiner Comments

This response scores 2 marks. The candidate has correctly described how the number of particles and the current has changed but has not referred to either the voltage or the link between current and charge.

Question 6 (a)

It was pleasing to see that many candidates had revised this area of the specification and produced some excellent responses in Q6(a). Most candidates knew that a nucleus (or atom) splits during fission, although there was some confusion as to what happens after this. Some candidates incorrectly named the products of fission as "daughter cells" whilst others thought that the daughter nuclei themselves split to further the chain reaction.

6 This question is about nuclear fission.

(a) The isotope uranium-235 can be made to undergo nuclear fission.

Describe the process of nuclear fission for uranium-235.

(4)

Fission in Uranium-235 is done by adding a neutron into the molecule which creates it to weaken and break into smaller molecules as well as producing more neutrons to break down the other molecules this repeats while alot of strong energy is released throughout everytime a molecule breaks.

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Examiner Comments

This candidate's response has the right general idea about the process of nuclear fission but the overall communication is not strong enough to merit more than 2 marks. The response was awarded marks for neutrons being produced in fission, in addition to the release of energy. MP1 was not awarded as the neutron is stated as being absorbed by a molecule, rather than a nucleus or atom. The nucleus breaking into smaller molecules is not clear enough for either MP3 or MP4 to be awarded.

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Examiner Tip

Questions about nuclear fission rely on clear, precise language when using technical terms and vocabulary.

6 This question is about nuclear fission.

(a) The isotope uranium-235 can be made to undergo nuclear fission.

Describe the process of nuclear fission for uranium-235.

(4)

First a neutron ~~Partiete~~ Part will be absorbed by a uranium-235 nucleus which will make it unstable and cause it to split into two daughter nuclei which are smaller and lighter. Along with that some other neutrons will also be exerted and travel around ~~eve~~ eventually to be absorbed by other Uranium 235 nucleus and ~~carry~~ continue the process of nuclear fission.

ResultsPlus
Examiner Comments

This is an excellent response that uses accurate, technical vocabulary to describe the fission process. It was awarded all marking points apart from MP2 and MP6 to gain full marks.

Question 6 (b)(i)

Regardless of whether the candidate was successful in gaining the marks, nuclear power safety and the potential hazards was the topic discussed in nearly every response. The weakest responses knew that the presence of the concrete shield was connected with safety. The weakest responses also mentioned the general dangers nuclear power could pose to the environment eg reactor explosion, contamination. There were also many candidates that knew that the function of the concrete shield was to absorb the radiation. The strongest responses said that gamma radiation, produced by the fission process is highly penetrating. A thick concrete shield is able to absorb and stop the gamma rays being emitted out into the surrounding environment. Many candidates were able to mention the specific harm the fission process posed to the surrounding environment eg radiation causes cell damage, cancer etc.

Question 6 (b)(ii)

Many candidates misinterpreted the focus of Q6(b)(ii) and wrote responses about why the pressure increases with temperature. Although some candidates gained a mark for the idea of particles colliding with the walls of the tubes, it was unusual for a response to be awarded more than 1 mark. The most able candidates had revised well-prepared explanations for this straightforward and common question.

(ii) The coolant from the nuclear reactor is used to heat steam to a very high temperature.

Steam is water in the gas state.

Using ideas about particles, explain why a pressure is exerted on the tubes containing the steam.

(3)

As particles ~~gain~~ are heated up, they gain energy and when they gain energy, more pressure is being made as the particles bounce off the walls more, creating ~~than~~ air pressure.

ResultsPlus
Examiner Comments

This candidate scored a single mark for the idea of the particles bouncing off the walls.

(ii) The coolant from the nuclear reactor is used to heat steam to a very high temperature.

Steam is water in the gas state.

Using ideas about particles, explain why a pressure is exerted on the tubes containing the steam.

(3)

Because the steam particles are in the tubes, the particles will collide with other particles and the walls of the container. And because the colant heats these particles, they will have alot of kinetic energy which increases the frequency of these collisions. The collisions create a force ~~on~~ exerted on the tubes. Because pressure = $\frac{force}{area}$, ~~[illegible]~~ a pressure is exerted.

ResultsPlus
Examiner Comments

This is an example of a high-level response. The candidate has clearly included all three marking points in their response.

Question 7 (a)(i)

Due to its inclusion in the attached formulae sheet, almost all candidates were able to write the correct formula in Q7(a)(i).

Question 7 (a)(ii)

Candidates produced some good responses in Q7(a)(ii) and most were able to score at least 2 marks. Some candidates realised that their answer needed to be multiplied by 1000 but did this at the end of the calculation without any justification. In this style of calculation, candidates are expected to clearly show how to get to the given value and this was not clear when a factor of 1000 was included at the end. Weaker candidates found rearranging the formula challenging and, although a mark was sometimes given for a correct substitution, these candidates usually scored zero.

(ii) Show that the maximum acceleration of Thrust SSC is approximately 20 m/s^2.

(3)

~~$a = \frac{F}{m}$~~

$a = \frac{f}{m}$

$= \frac{223}{10600}$

$= 0.021 \times 1000$

$= 21\ m/s^2$

ResultsPlus Examiner Comments

This candidate scored 2 marks. They have rearranged the formula correctly and substituted the given values sufficiently, although the conversion of kN to N is not seen. They have not been awarded the final mark since the factor of x1000 at the end is unclear. No BOD was given that this was the conversion of KN to N since the final answer was known to candidates.

Question 7 (b)

Only a minority of candidates selected the correct formula in Q7(b), but usually scored full marks if they did so. Most candidates opted to use speed = distance / time, which usually resulted in no marks being awarded.

Paper Summary

Based on their performance on this paper, candidates should:

- take note of the number of marks given for each question and use this as a guide as to the amount of detail expected in the answer.
- take note of the command word used in each question to determine how the examiner expects the question to be answered, for example, whether to give a description or an explanation.
- be able to rearrange the formulae listed in the specification.
- know the SI units for physical quantities and be able to convert from non-SI units to SI units when required.
- show all working, so that some credit can still be given for answers that are only partly correct.
- take advantage of opportunities to draw labelled diagrams as well as, or instead of, written answers.

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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