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Examiners' Report
June 2024

Int GCSE Physics 4PH1 1PR

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Introduction

As in examinations for previous sessions, most candidates handled the calculations well. Candidates who gave the best practical descriptions usually appeared to be writing from first-hand experience.

Responses to the longer questions showed that less able candidates tend to struggle when assembling a logical description or when asked to offer more than one idea.

There was a wide range of responses and it was good to see that many candidates could give full and accurate answers.

Question 1 (a)(i)-(ii)

Most candidates selected the correct areas of the electromagnetic (EM) spectrum for both parts of this item. Attempts which were phonetically correct or recognisably misspelt were also accepted.

Question 1 (b)(i)

Most candidates described some relevant use of microwave radiation.

Question 1 (b)(ii)

Most candidates described some relevant use of gamma rays.

The list in the mark scheme was not exhaustive but accounted for the vast majority of responses.

Question 2 (a)

Most candidates made reference to one of the three acceptable answers on the mark scheme.

Question 2 (b)(i)-(ii)

This calculation proved relatively straightforward to most candidates, although some made a small slip with the conversion from watts to the required kilowatts.

Question 2 (c)

Candidates broadly found this item challenging.

This sort of question, with 'suggest' as the command word, requires the candidate to think more about the context and how the relevant physics applies.

Question 3 (a)(i)

Candidates found this item straightforward, assuming they selected the correct speed. If candidates were going to lose a mark, it was for where they forgot the conversion from hours to seconds or did so incorrectly.

Question 3 (a)(ii)

Candidates can answer this type of experimental item by asking themselves three things:

- what quantity or quantities do I need to measure;
- what instrument or instruments should I use;
- what would I do with those measurements to calculate the required quantity.

(ii) During the test, the vehicle travelled past two markers.
The markers were placed a known distance apart.

Describe how these markers could be used to determine the speed of the vehicle.

(3)

By recording the time taken by the vehicle to travel from one marker to the other marker, and by measuring the distance between each marker, using the equation speed = $\frac{\text{distance}}{\text{time}}$, we can find the speed of the vehicle.

ResultsPlus Examiner Comments

This candidate did well to explain what they were going to measure and what they would do with that measurement. They missed out what instrument or instruments they should use.

ResultsPlus Examiner Tip

Always remember to mention what instrument(s) you would use to measure each quantity as well as what you intend to do with that quantity ie calculate something else such as a velocity.

(ii) During the test, the vehicle travelled past two markers.
The markers were placed a known distance apart.

Describe how these markers could be used to determine the speed of the vehicle.

(3)

By using a light gate on the first marker, as soon as vehicle travelled past first marker, timer will turn on. When the vehicle crosses the second marker, which also has a light gate, the timer will stop. Now, as we know the distance already, find speed using speed = $\frac{\text{distance}}{\text{time}}$.

ResultsPlus
Examiner Comments

This candidate did the same as the previous candidate except they also mentioned how they were going to measure the time taken between the two markers.

The use of light gates is not mandatory – a stopwatch or timer would have been sufficient.

ResultsPlus
Examiner Tip

Be careful when describing using light gates or other data logging apparatus.

Question 3 (b)

Most candidates scored at least one mark here by drawing an arrow to the left.

Fewer candidates got the length of the arrow approximately correct.

Finally, a reasonable proportion of candidates labelled the left-pointing arrow with an appropriate force name.

Question 4 (a)

This question showed that some candidates had muddled the evolutions of low mass stars such as the sun, and much more massive stars. Those candidates would select red supergiant and black hole instead of red giant and white dwarf, generally speaking.

Question 4 (b)

Candidates broadly scored at least one mark for realising that the colour of the stars and hence the surface temperatures of the two stars are different. The majority of candidates remembered which was hotter than which.

Question 4 (c)(i)

Many candidates would essentially repeat the question or make references to solids, liquids and/or gases. Less than half of candidates correctly mentioned the lack of particles between the Earth and the Sun.

Question 4 (c)(ii)

The key to questions about emission and absorption is to work out which way the transfer by heating is going. In this case the hotter object is the sun and the cooler object is the satellite. It is clear, therefore, that we should discuss the absorption properties of the satellite. Most candidates recognised this and made good attempts at answering this question.

(ii) A satellite orbiting the Earth contains sensitive equipment that can be damaged if it gets too hot.

Explain which colour would be most appropriate for the outer surface of the satellite to protect the equipment.

(2)

White colour as it is a poor absorber of infrared (IR) radiation.

ResultsPlus
Examiner Comments

This candidate produced an excellent concise answer covering both marking points.

ResultsPlus
Examiner Tip

Think about which part of the specification is the theme of the question and then try to be concise where you can.

(ii) A satellite orbiting the Earth contains sensitive equipment that can be damaged if it gets too hot.

Explain which colour would be most appropriate for the outer surface of the satellite to protect the equipment.

(2)

The oute surface of the satellite should be ~~pa being to~~ be in white / painted in white. This is because the color white reflects light from its surface which can prevent the sensitive equipment being ~~heated~~ heated.

ResultsPlus
Examiner Comments

This candidate's response was not as concise as the previous example. They have lost the mark here for not referring to heat, infra-red or heat energy.

Question 5 (a)

There are 13 experiments that candidates should have either seen, or better still, performed themselves. This item refers to one of them: determining the density of a material.

This time, however, the focus was not on the eventual calculation but on how to take the required measurements. The mark scheme focuses on this aspect of the procedure.

5 A student needs to determine the density of some small rocks that appear to all be made of the same material.

(Source: © Chake / Shutterstock)

(a) The student decides to measure the mass and the volume of each rock.

Describe a method the student could use to accurately determine the mass and the volume of each rock.

You may draw a diagram to help your answer.

(5)

repeat for each rock

measure the mass using a balance. keep it on a flat surface to get accurate reading and avoid zero.
To measure volume place water in a measuring cylinder, measure the volume. Add the rock into the cylinder, measure volume of water. subtract the final volume from initial volume. repeat for each rock. measure volume perpendicular and at eye level to avoid parallax error. measure from the bottom to improve accuracy.

ResultsPlus
Examiner Comments

This candidate has scored all five marks. They have made clear right from the outset which instruments they are going to use (balance and measuring cylinder).

They have gone on to describe the displacement method successfully.

This candidate has taken great trouble to outline the procedure they would actually perform, such as:

- making sure the balance is reading zero before placing the rock;
- making sure the balance is on a flat surface;
- **how** they would avoid parallax error, rather than merely stating 'avoid parallax error', whilst not quite mentioning measuring to the bottom of the meniscus.

ResultsPlus
Examiner Tip

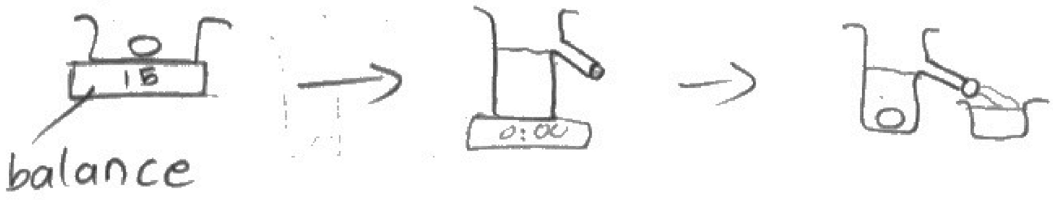
Wherever possible, centres and candidates should try to perform experiments themselves and note exactly what they do to collect all of the necessary data.

(a) The student decides to measure the mass and the volume of each rock.

Describe a method the student could use to accurately determine the mass and the volume of each rock.

You may draw a diagram to help your answer.

(5)



By using displacement method. At first measure the mass of (~~beaker +~~ water) and also mass of ~~rock~~ each rock using an electronic balance. Submerge the rock in the water. ~~Ta~~ And ~~as~~ some of the water ~~which~~ overflows and goes to the other beaker. Take the mass of those water from the other beaker. Subtract ~~original~~ final value of water ~~-~~ from original value. Use equation volume = $\frac{\text{mass}}{\text{density}}$ to calculate the ~~ma~~ volume.

ResultsPlus
Examiner Comments

This candidate has done a good job of describing the experiment here. They have drawn a diagram to help their answer – this has given rise to the marking point that the rock should be completely submerged.

The displacement method is present however there is no mention of a measuring cylinder.

The addition of the formula is irrelevant here.

Question 5 (b)

As the candidates received all formulae, part (b)(i) proved straightforward.

The mark scheme shows that there is credit for stating that the different material will be identified by the different densities. To do that effectively, the densities of all three materials must be calculated.

Finally, the mark scheme required a definite statement or conclusion consistent with their calculations.

(b) The table shows the student's results for three of the rocks.

Rock	Mass in g	Volume in cm^3	
A	15	6.3	2.38
B	13	6.1	2.13
C	16	7.5	2.13

(i) State the formula linking density, mass and volume.

(1)

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(ii) After looking at the data, the student concludes that one of the rocks may be made of a different material from the others.

Using the data from the table, justify the student's conclusion.

(4)

$\rho = m \div V$ $\rho_A = 15 \div 6.3 = 2.38\ g/cm^3$ $\rho_B = 13 \div 6.1 = 2.13\ g/cm^3$

$\rho_C = 16 \div 7.5 = 2.13\ g/cm^3$

The density of the rock A is different from the density of rock B and rock C. So the ~~student~~ student's conclusion is ~~to~~ ~~right~~ right

ResultsPlus
Examiner Comments

This is an excellent example of how to answer this question succinctly.

(i) State the formula linking density, mass and volume.

(1)

$$density = \frac{mass}{volume}$$

(ii) After looking at the data, the student concludes that one of the rocks may be made of a different material from the others.

Using the data from the table, justify the student's conclusion.

(4)

The student is correct as rock C has a higher mess when he meesured it and it also has a higher volume than the other rocks and using the table he can find the density of each one of the rocks by ussing the formula $density = \frac{mess}{volume}$. Rock ~~A~~ C would have a higher density than the ~~rest~~ ~~res~~ other rocks which indicates that it is a different type of rock. which would conclude that one of the rocks is a different type of rock than the others.

ResultsPlus
Examiner Comments

This candidate has not used the data at all, limiting themselves to 1 mark for part (b)(ii)

ResultsPlus
Examiner Tip

Look carefully at the command sentence. Here this is "Using the data from the table...".

Answers must therefore have significant reference to the data in the table and some processing of that data.

(i) State the formula linking density, mass and volume.

density = $\frac{mass}{volume}$

(1)

(ii) After looking at the data, the student concludes that one of the rocks may be made of a different material from the others.

Using the data from the table, justify the student's conclusion.

(4)

A: $\frac{15}{6.3}$ = 2.381 cm³/g B: $\frac{13}{6.1}$ = 2.131 cm³/g C: $\frac{16}{7.5}$ = 2.133 cm³/g

A may be made of a different material.

ResultsPlus
Examiner Comments

This candidate calculated all three densities, hence scoring three marks.

The fourth mark was withheld because the candidate did not spell out how they knew that A was a different material. In other words, they assumed that the marker would put that step in for them.

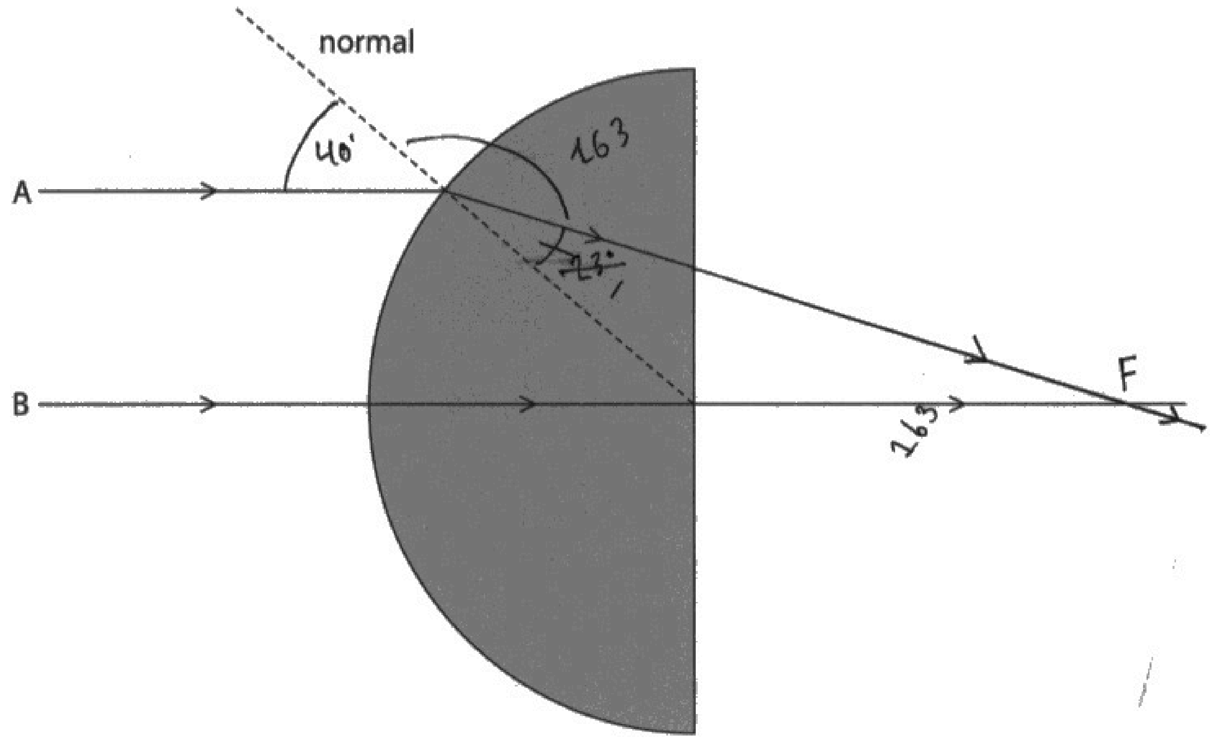
ResultsPlus
Examiner Tip

Always write a valid conclusion that is not simply repeating the question.

Question 6 (a)(i)-(iii)

Many candidates measured the angles required correctly, although some measured from the block's surface instead of from the normal. Again the equation was given so virtually all candidates got that right. A common misconception, even with the correct formula, is that dividing the two angles will give the refractive index.

6 The diagram shows two rays of green light entering a semicircular glass block.



(a) (i) Measure the angle of incidence and the angle of refraction for ray A as it enters the glass block.

(2)

angle of incidence = 40° degrees

angle of refraction = ~~23°~~ 163° degrees

(ii) State the formula linking refractive index, angle of incidence and angle of refraction.

(1)

refractive index = $\frac{\sin(\text{angle of incidence})}{\sin(\text{angle of refraction})}$

(iii) Calculate the refractive index of the glass.

(3)

$\frac{\sin 40}{\sin \cancel{23}\ 163}$ = ~~1.645089328 ≈ 1.6~~

2.198 ≈ 2.2

refractive index = ~~1.6~~ 2.2

ResultsPlus
Examiner Comments

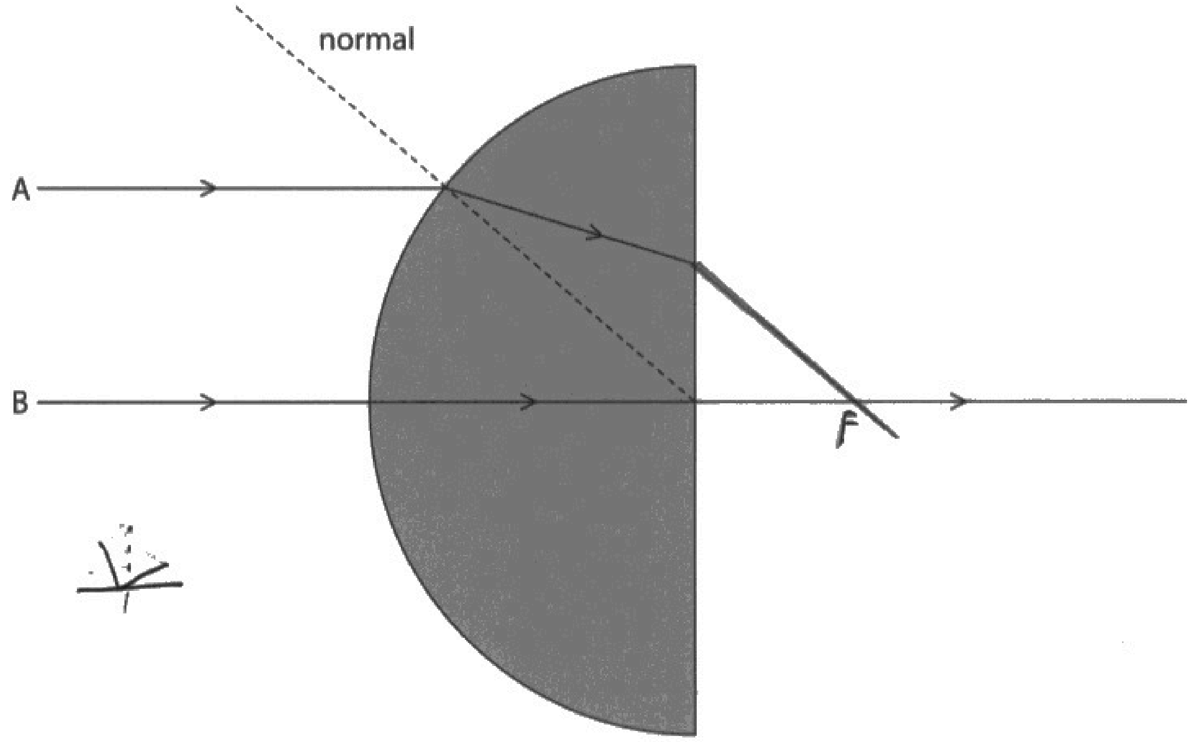
While this candidate made a mistake in measuring the angle of refraction – they had measured from the wrong side of the normal – they have completed the rest of the question perfectly.

1 mark lost for the incorrect measurement, the rest of the marks were awarded Error Carried Forward (ECF).

ResultsPlus
Examiner Tip

Always measure the smallest angle from the normal – in this case inside the block.

6 The diagram shows two rays of green light entering a semicircular glass block.



(a) (i) Measure the angle of incidence and the angle of refraction for ray A as it enters the glass block.

(2)

angle of incidence = 50. degrees

angle of refraction = 67. degrees

(ii) State the formula linking refractive index, angle of incidence and angle of refraction.

refractive index = $\left(\frac{\sin(\text{angle of incidence}}{\sin(\text{angle of refraction}}\right)$ **(1)**

(iii) Calculate the refractive index of the glass.

(3)

$$\frac{50}{67} = 0.746.$$

refractive index = 0.746.

ResultsPlus
Examiner Comments

This candidate had mismeasured both angles here yet had got the formula correct.

Unfortunately they ignored their formula and merely divided the two angles.

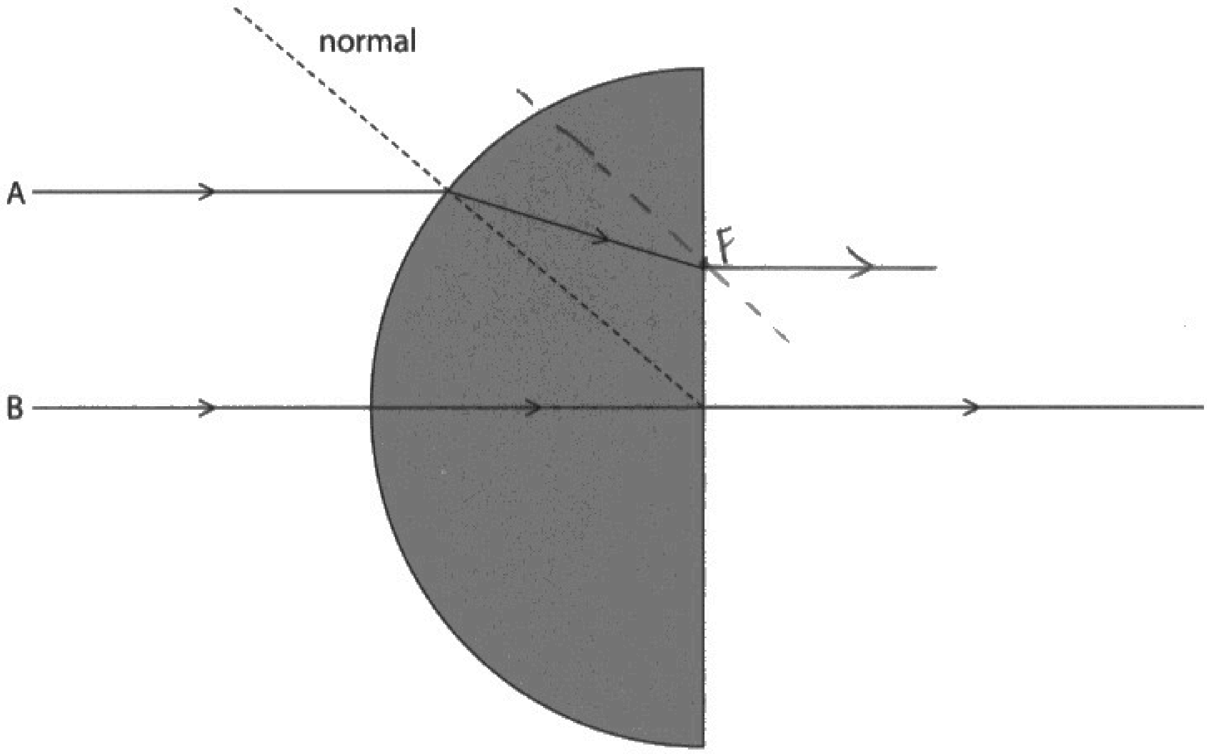
ResultsPlus
Examiner Tip

Take care to use the formula that you have already written. This is the sort of error a check through at the end might spot.

Question 6 (b)(i)

Very few candidates got the direction of refraction backwards or had the ray emerging at 90 degrees to the block. If candidates remembered which way the light bent, then two marks were virtually assured.

6 The diagram shows two rays of green light entering a semicircular glass block.



(b) (i) Complete the path of ray A until it crosses ray B.

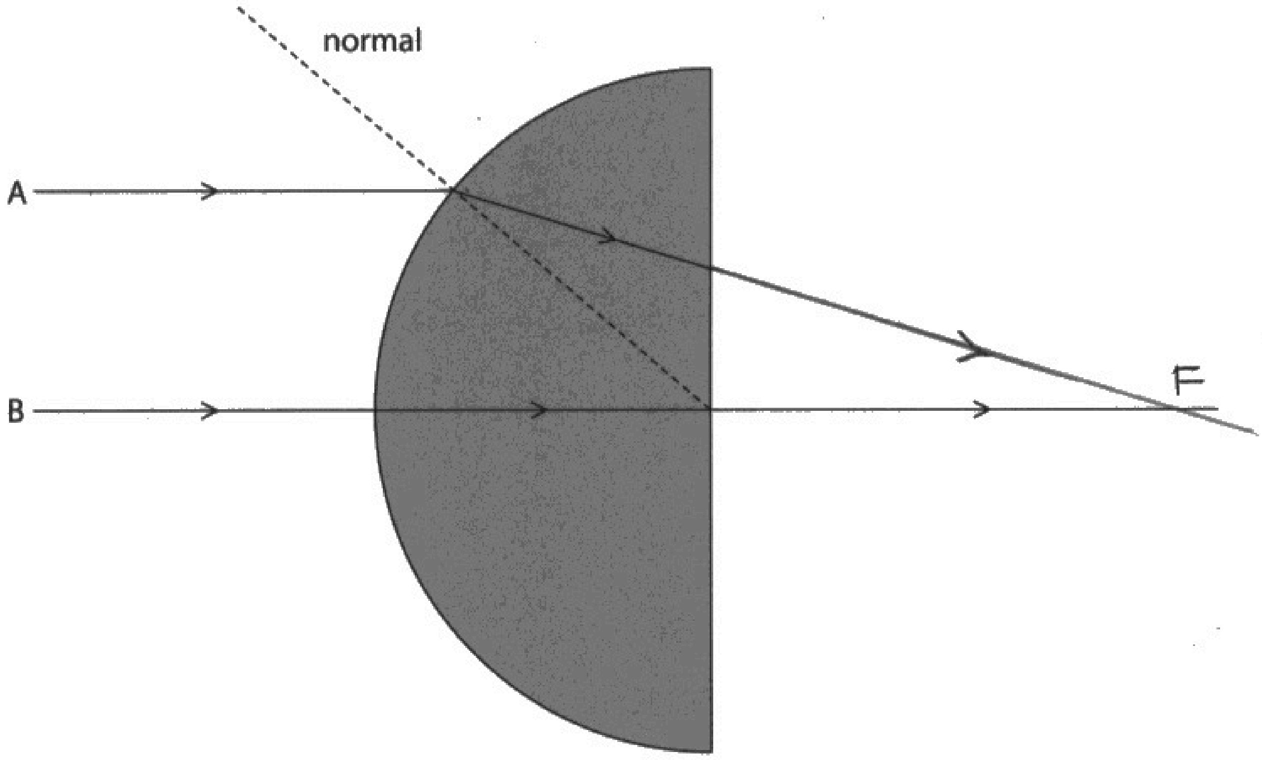
Label the point where the rays cross with the letter F.

(2)

ResultsPlus
Examiner Comments

This candidate scored zero because the ray they drew emerged at 90 degrees to the block, which cannot be true.

6 The diagram shows two rays of green light entering a semicircular glass block.



(b) (i) Complete the path of ray A until it crosses ray B.

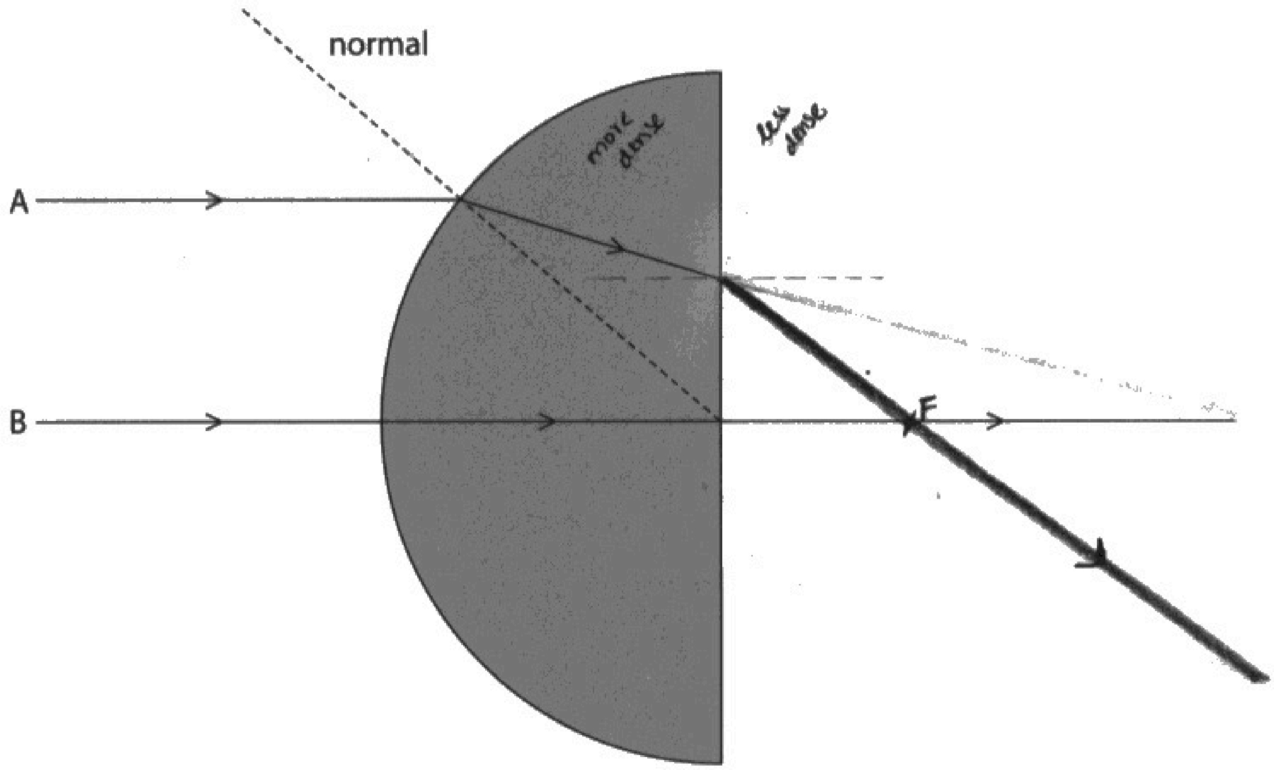
Label the point where the rays cross with the letter F.

(2)

ResultsPlus
Examiner Comments

This candidate scored a mark because their emergent ray crossed ray B on the correct side of the block. There was no bending of the ray, however.

6 The diagram shows two rays of green light entering a semicircular glass block.



(b) (i) Complete the path of ray A until it crosses ray B.

Label the point where the rays cross with the letter F.

(2)

ResultsPlus
Examiner Comments

This candidate scored both marks because the ray bent in the correct direction and then crossed ray B on the correct side of the block.

The marker took the dashed lines to be construction lines and/or rubbed out lines still captured by the scanning process.

ResultsPlus
Examiner Tip

Avoid using a pen for diagram questions if you can.

Question 6 (b)(ii)

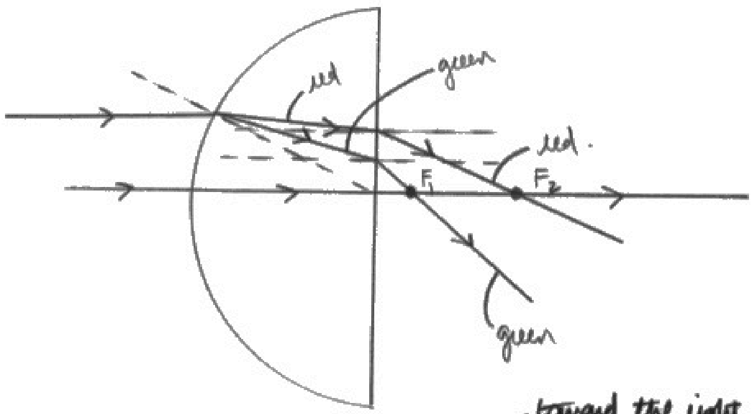
A genuinely challenging item, largely because it called for understanding and reasonable technical language. The first mark is relatively soft, however, the next two are quite hard, requiring deep understanding of what happens when the refractive index changes.

(ii) The refractive index of glass for red light is lower than for green light.

Explain what would happen to point F if red light were used instead of green light.

You may draw a diagram to help your answer.

(3)



Point F would be further away toward the light as the angle of refraction would be greater than that for green light if the angle of incidence were the same. Therefore, the emergent ray angle would also be less than that of the green light.

ResultsPlus Examiner Comments

This candidate has done very well, making their thoughts clear with an excellent diagram.

ResultsPlus Examiner Tip

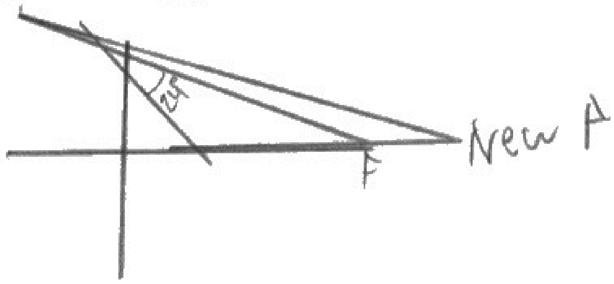
If the question suggests drawing a diagram, then a good diagram would definitely help. Diagrams can often help clarify what would otherwise be slightly ambiguous verbal responses.

(ii) The refractive index of glass for red light is lower than for green light.

Explain what would happen to point F if red light were used instead of green light.

You may draw a diagram to help your answer.

(3)



If the refractive index is lower, light rays will bend away from the normal. Therefore, F will be farther away from the mirror if the refractive index is lowered.

ResultsPlus
Examiner Comments

This candidate has also drawn a broadly correct diagram however has not used relevant physics to explain why point F has moved out.

Question 7 (a)

A typical circuit diagram question here. Most candidates made a good effort, although many did not remember the circuit symbol for a variable resistor. The circuit symbols can be found in the specification, appendix 8.

7 A student investigates the voltage-current characteristics of an unknown component, X.

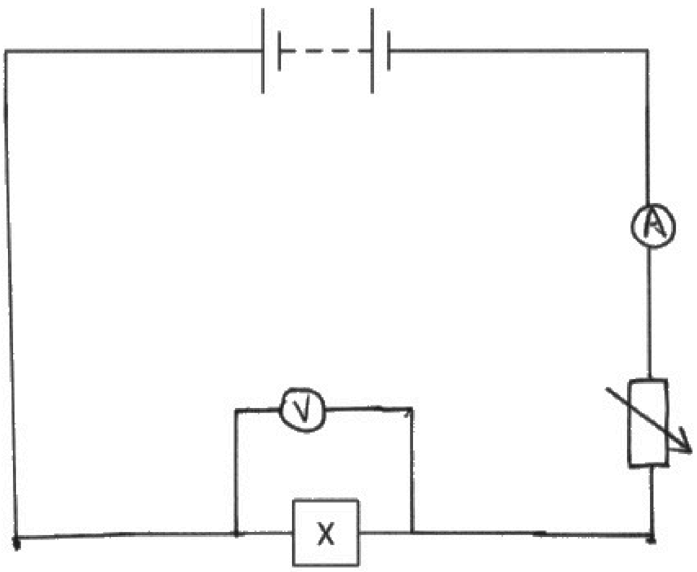
(a) The student is given this equipment to investigate component X.

- battery
- variable resistor
- ammeter
- voltmeter
- connecting wires

The diagram shows an incomplete circuit containing the battery and component X.

Complete the diagram by drawing a circuit the student could use for their investigation.

(4)



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Examiner Comments

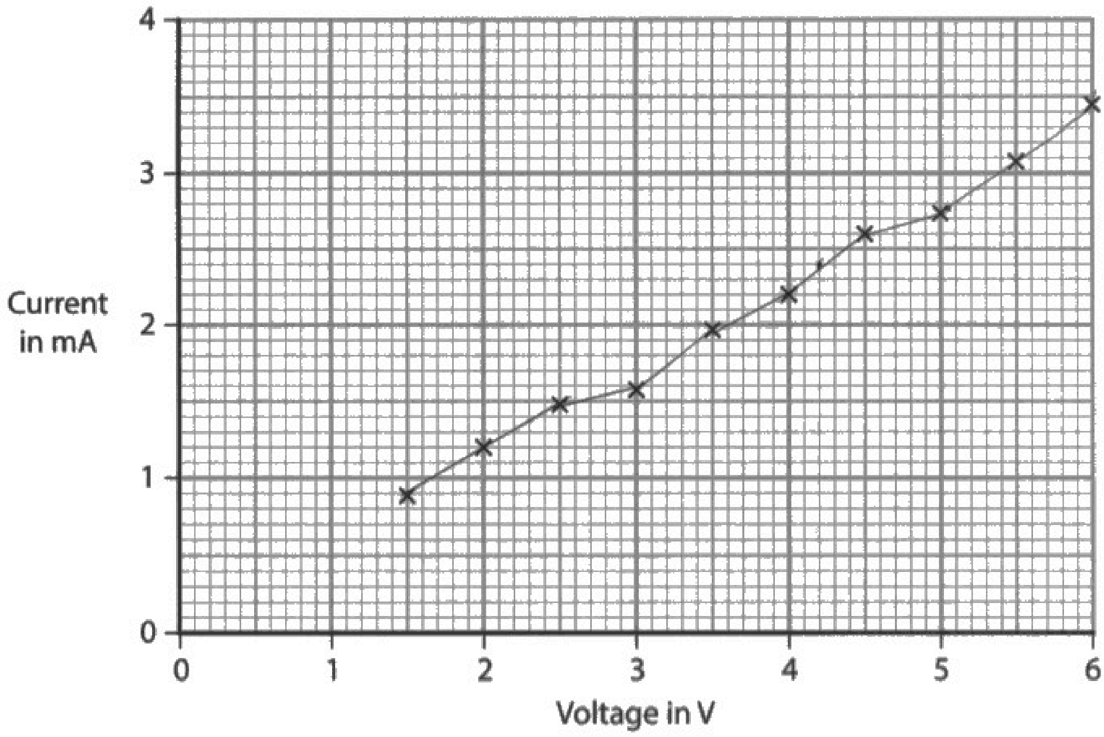
This is an excellent diagram which clearly scores all four marks.

Drawing of connecting wires with a straight edge or ruler is not mandatory yet can help with clarity.

Question 7 (b)(i)-(ii)

The points fell on a good straight line so the candidates broadly did a good job of drawing the line of best fit. The calculation also went very well, with some candidates getting the unit wrong or getting the power of ten wrong. This might have been by using kiloohms instead of ohms.

(b) The graph shows the results of the investigation.



(i) Draw a line of best fit on the graph.

(1)

(ii) Calculate the resistance of component X when the voltage is 4.2V.

Give the unit.

(5)

$\frac{4.2V}{2.4mA} = 1.75$

resistance = 1.75 unit V/MA

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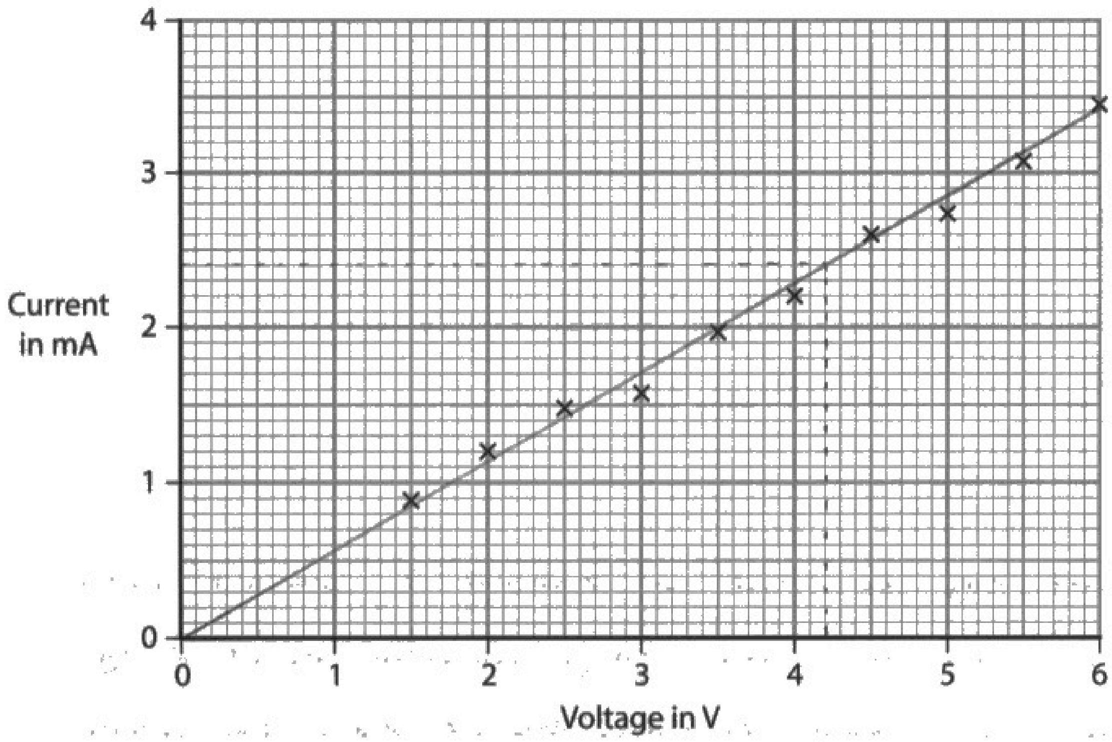
Examiner Comments

Although the candidate has not drawn a straight line of best fit, they have read off the current in mA correctly. The calculation is also complete however there is a power of ten error plus a unit error. Only ohms or some multiple of ohms was acceptable. Although V/mA is a reasonable guess it is not standard SI practice here.

(b) The graph shows the results of the investigation.



(i) Draw a line of best fit on the graph.

(1)

(ii) Calculate the resistance of component X when the voltage is 4.2 V.

Give the unit.

(5)

Current at 4.2V = 2.4mA

= 0.0024 A

V = IR

$\frac{4.2V}{0.0024A} = R$

R = 1750 Ω

resistance = 1750 unit Ω (ohms)

ResultsPlus
Examiner Comments

In contrast, this candidate has drawn a fair straight line with the right number of points above and below it.

They have gone on to read off the current correctly, convert the current in amps and then completed the calculation with the right unit, hence full marks awarded.

Question 7 (b)(iv)

This item required some graphical analysis and evaluation. With all such questions, simply describing what the shape of the graph is then explaining what it should be is often sufficient.

(iv) The student concludes that component X is a filament lamp.

Comment on the student's conclusion.

(2)

~~Yes, it is a filament lamp.~~

The line is a straight line passing through the origin.

So it is a filament lamp.

ResultsPlus
Examiner Comments

The candidate has spotted that the line is straight and passes through the origin, however has not correctly stated what the relevance of that is. The conclusion is incorrect.

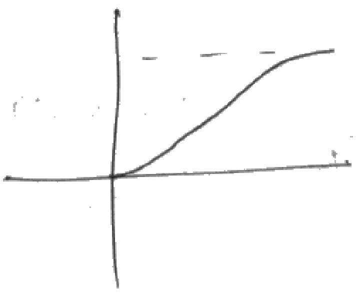
(iv) The student concludes that component X is a filament lamp.

Comment on the student's conclusion.

(2)

- It is not a filament lamp, as current is directly proportional to voltage, as the line of best fit is a straight line that goes through origin
- In a filament lamp, the graph has a curve at high currents & voltages, the curve's gradient reduces as resistance increases

(Total for Question 7 = 13 marks)



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Examiner Comments

In contrast, this candidate has made their thinking very clear, again with a reasonable sketch graph to clarify their approach.

Question 8 (a)(ii)

This is a standard definition. By far the most economical version of this definition is "the time taken for the activity to halve."

(ii) Iodine-131 is radioactive and decays with a half-life of 8 days.

State what is meant by the term **half-life**.

(2)

It is ~~It~~ the time taken for ~~a rad random radioactive decay to happen,~~ half the amount of radioactive substance to randomly undergo radioactive decay.

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Examiner Comments

'Half the amount of radioactive substance' was insufficient for the second mark.

ResultsPlus
Examiner Tip

Try to use standard scientific terms for definitions where possible.

(ii) Iodine-131 is radioactive and decays with a half-life of 8 days.

State what is meant by the term **half-life**.

(2)

Time taken for the nucleus of an element to decay half of its life.

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Examiner Comments

This example is also incorrect because it implies that there is only one nucleus decay, which isn't correct.

Question 8 (a)(iii)-(iv)

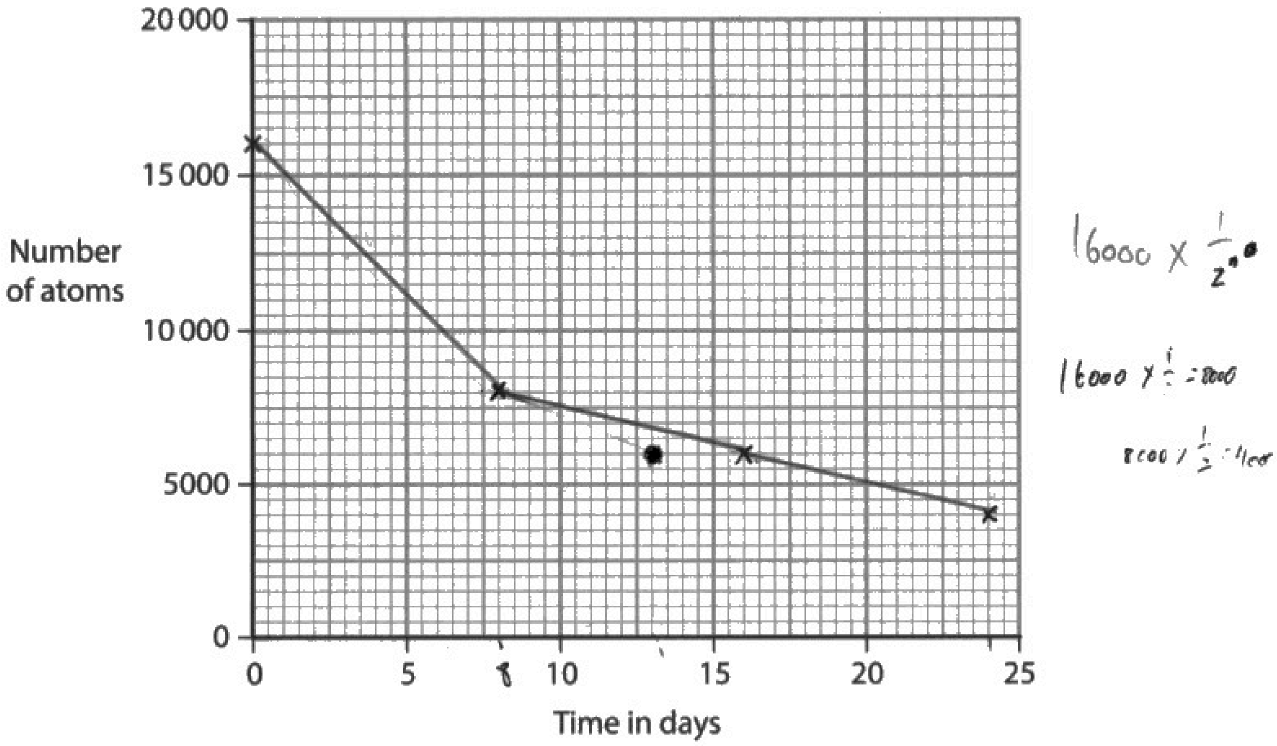
There is a lot to do in this item. Even if the candidate's wording in the previous part was imperfect, this item needs the idea that the number of nuclei halves every half-life. Many candidates achieved this.

(iii) The cross (×) on the graph shows the initial number of atoms in a sample of iodine-131.

Draw three more crosses (×) on the graph to show how the number of atoms of iodine-131 in the sample changes during three half-lives.

[iodine-131 half-life = 8 days]

(3)



(iv) Use a curve of best fit on the graph to estimate the time taken for the number of atoms in the sample to decrease to 5000.

(2)

time taken = 20 d

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Examiner Comments

The first cross here is perfect, however the remaining two are incorrect.

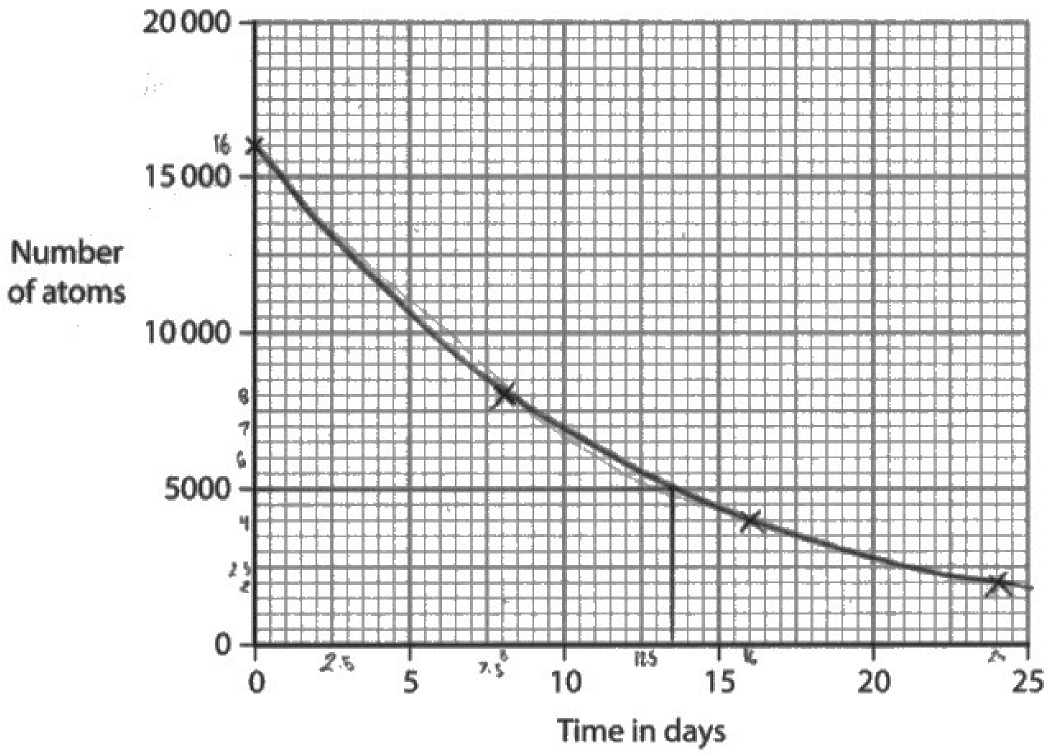
The candidate has not followed the instructions to draw a curve through their data. They have, however, read off the graph at the correct point to score the last mark ECF.

(iii) The cross (×) on the graph shows the initial number of atoms in a sample of iodine-131.

Draw three more crosses (×) on the graph to show how the number of atoms of iodine-131 in the sample changes during three half-lives.

[iodine-131 half-life = 8 days]

(3)



(iv) Use a curve of best fit on the graph to estimate the time taken for the number of atoms in the sample to decrease to 5000.

(2)

time taken = 13.5 days

ResultsPlus
Examiner Comments

This candidate has plotted the points correctly then drawn a curve.

To finish, they have read off the time correctly from their curve.

Note that if the candidate had not drawn crosses, the marks would still have been awarded as the curve goes through the correct points.

Question 8 (b)(i)

Most candidates successfully gave a suitable radiation detector.

Question 8 (b)(ii)

There were only two pieces of technical language that were acceptable here ie a reference to ionising power or penetrating power as expressed in the mark scheme.

Question 8 (c)

The candidates were told that the half-life of technetium is lower so there was no credit for saying that. The candidates needed to go one step further here, to explain what the effect of that shorter half-life was. Alternatively, making reference to the difference in ionisation power and therefore effect on the body was a sensible strategy.

(c) Technetium-99m is another radioactive isotope.

Iodine-131 and technetium-99m are both used as medical tracers. Medical tracers use radiation detected outside the body to diagnose illnesses.

The table gives information about some of the properties of iodine-131 and technetium-99m when they undergo radioactive decay.

Isotope	Type(s) of radiation emitted	Half-life
iodine-131	beta and gamma	8 days
technetium-99m	gamma	6 hours

Explain why technetium-99m is likely to be safer than iodine-131 when used as a medical tracer.

(3)

It has a shorter half-life so will decay faster in the body and not remain for a long period of time, it only produces gamma which is able to penetrate outside the body, so all of it can be detected. It doesn't stay for a long time so adverse effects are less likely. ~~Cancer~~ Risk of cancer and contamination are lower.

ResultsPlus
Examiner Comments

This is an excellent response and has covered all of the marking points very clearly.

(c) Technetium-99m is another radioactive isotope.

Iodine-131 and technetium-99m are both used as medical tracers. Medical tracers use radiation detected outside the body to diagnose illnesses.

The table gives information about some of the properties of iodine-131 and technetium-99m when they undergo radioactive decay.

Isotope	Type(s) of radiation emitted	Half-life
iodine-131	beta and gamma	8 days
technetium-99m	gamma	6 hours

Explain why technetium-99m is likely to be safer than iodine-131 when used as a medical tracer.

(3)

Its half life is shorter than iodine-131, so the time taken that stay in body is shorter than iodine-131. The damage is the lowest.

ResultsPlus
Examiner Comments

This candidate has scored the mark for expanding on the idea that the half-life of iodine-131 is shorter so will stay in the body for a shorter period of time. The second sentence is too vague to be applicable to any of the available marking points.

ResultsPlus
Examiner Tip

Make sure for multi-mark questions that you have said at least as many different things as there are marks available. Repeating the question cannot be creditworthy.

Question 9 (a)(i)

There was only one acceptable, short answer here.

Question 9 (a)(ii)

There was only one acceptable, short answer here.

Question 9 (a)(iii)

The candidates needed to identify the object that was the source of the energy or which energy store that object possessed an increased store of. In this case it was chemical energy.

Question 9 (b)(i)

All the candidates needed to do here was identify that the line was not straight. Noticing that the unloading and loading graphs were different, which could only be true if the graphs were not straight, was also acceptable.

Question 9 (b)(ii)

Many candidates stated that the elastic property was clear from the line returning to the origin. Rather fewer included the proviso that this happens when the loading force is removed.

Question 9 (c)(i)

This calculation can prove challenging for some candidates. A clear substitution will help although there is little alternative than sustained practice here.

(c) The student stretches the rubber band and then releases it. The band moves vertically upwards.

(i) The band travels with an initial speed of 13 m/s.

When the band reaches its maximum height above the student's hand, the band has a speed of 0 m/s.

Calculate the maximum height that the band reaches.

Give your answer to 2 significant figures.

[acceleration due to gravity = −10 m/s²]

(4)

$v^2 = u^2 + 2as$

$0 = 13^2 + 2(-10)(s)$

~~1697~~ $169 - 20s = 0$

$169 = 20s$

$s = \frac{169}{20} = \underline{8.45} = 8.5$

maximum height = 8.5 m

ResultsPlus
Examiner Comments

An excellent response. All of the working is very clear with a correct answer on the answer line.

(c) The student stretches the rubber band and then releases it. The band moves vertically upwards.

(i) The band travels with an initial speed of 13 m/s.

When the band reaches its maximum height above the student's hand, the band has a speed of 0 m/s.

Calculate the maximum height that the band reaches.

Give your answer to 2 significant figures.

[acceleration due to gravity = −10 m/s²]

(4)

$v^2 = u^2 + (2 \times a \times s)$

$-13^2 = 13^2 + (2 \times -10 \times s)$

$-13^2 = 169 + -20 \times s$

$-13^2 = 149 \times s$

$s = \frac{-13^2}{149}$

$s = \frac{169}{144}$

$s = 1.1$ m

maximum height = 1.1 m

ResultsPlus
Examiner Comments

The candidate has substituted the correct numbers into the given formula, at least at first.

The first error is changing the final speed from 0 to 13.

The second error is subtracting 20 from 169 to give 149 on the right hand side of the equation. This was quite a common error.

The score is 1 mark, though, because the candidate quoted their answer to 2 significant figures.

Question 9 (c)(ii)

Some candidates recognised that this was essentially intended to test their understanding of non-uniform accelerated motion. The question specifically stated that the band did not reach terminal velocity, so any reference to 'drag = weight' were irrelevant. No accelerated motion can occur without a resultant force, so describing what forces comprise that resultant force, and how those forces change with speed is an excellent place to start.

A small minority of candidates described the motion entirely in terms of energy transfers, often correctly, even though the question specifically stated that candidates should refer to forces in their answer.

(ii) The band reaches its maximum height.

Explain the motion of the band as it falls from its maximum height to the ground.

Refer to forces in your answer.

You may assume

- the band does not rotate
- the band does not reach terminal velocity

(5)

As band falls weight acts downwards causing band to accelerate. Air resistance increases so resultant force decreases so acceleration decreases. After sometimes resultant force is zero as air resistance = weight so band falls at constant velocity.

ResultsPlus
Examiner Comments

This candidate has scored all five marks in the first two sentences.

ResultsPlus
Examiner Tip

This candidate had apparently used previous mark schemes for this set of ideas. Some of the response was inapplicable, so be careful and read directives such as 'the band does not reach terminal velocity'.

(ii) The band reaches its maximum height.

Explain the motion of the band as it falls from its maximum height to the ground.

Refer to forces in your answer.

You may assume

- the band does not rotate
- the band does not reach terminal velocity

(5)

• When the band reaches its maximum height, the force of gravity is the least present at maximum height.
• As it ~~fall~~ starts to fall, air resistance force is present, opposing the weight of the ~~ball~~ band.
• Gravity ~~is~~ attracts the person to go downwards, the ~~ball~~ band first starts to fall very quickly.
• when the ~~ball~~ band starts to slow down, air resistance force starts to decrease, while gravitational force increases.
• when it hits the ground all forces have stopped acting on it except gravitational force, it's present the most ~~at at~~ at this point.

ResultsPlus
Examiner Comments

At first glance, this explanation appears a little muddled. There is still creditworthy material here, though.

There is mention of air resistance and a reference to the force of gravity on the band.

Again, this question is subtly different from other questions in previous series that have asked about terminal velocity. The mention of hitting the ground is irrelevant.

Question 10 (a)

There were some excellent answers here, especially from those candidates that resisted jumping straight to the idea that a current was induced. Induced currents are the result of an induced voltage in a complete circuit.

10 Diagram 1 shows a generator inside a small wind turbine. The generator is connected to a lamp and the windmill blades.

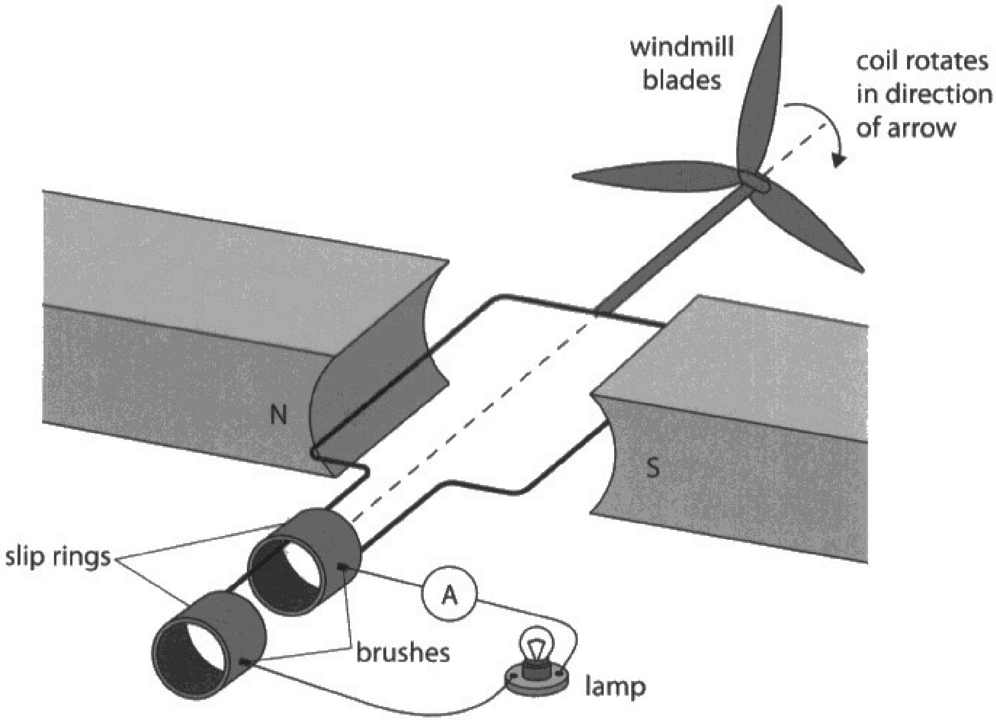


Diagram 1

(a) When the coil rotates in the direction of the arrow, the ammeter displays a small current.

Explain how the generator produces a current.

(2)

→ The coil carries temporay wire
→ bar magnets are permanant wire
→ feild lines are cut by the coil. North to South
→ This induces current in the ~~torbine~~ generator that causes turbine to rotate.

ResultsPlus
Examiner Comments

The candidate has scored a mark here for mentioning that the field lines are cut by the coil. This is even though the rest of the response has no rewardable content.

(a) When the coil rotates in the direction of the arrow, the ammeter displays a small current.

Explain how the generator produces a current.

(2)

as the wire spins it cuts through the magnetic field and induces a voltage

ResultsPlus
Examiner Comments

This concise answer clearly scores both marks.

ResultsPlus
Examiner Tip

Electromagnetic induction is amongst the most challenging topics on the specification. Candidates may make progress if they approach this particular content with a sequence of events in mind.

Question 10 (b)(i)

Most candidates mentioned the property of a diode or the definition of direct current. Very few candidates did both, which was required for both marks.

(b) The generator in the wind turbine acts as an alternating current (a.c.) power supply.

Diagram 2 shows an electric circuit containing the generator being used to charge a mobile phone battery.

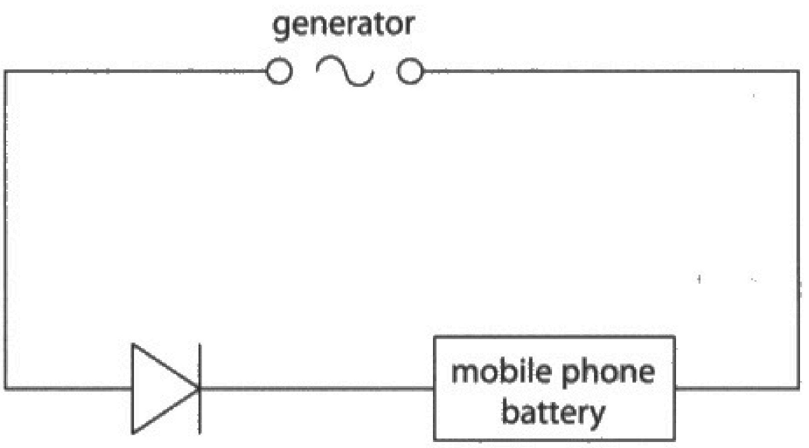


Diagram 2

(i) Direct current (d.c.) is needed to charge the battery.

Explain why there is a diode in the circuit.

(2)

Diode is used to allow the current to flow in one direction with a high resistance.

ResultsPlus
Examiner Comments

There is a spurious statement about the diode's resistance when it is allowing current to flow. Other than that, the candidate states that they know that the diode will cause the current to flow in a single direction. There is no connection of that to direct current, so only one mark awarded here.

(i) Direct current (d.c.) is needed to charge the battery.

Explain why there is a diode in the circuit.

(2)

Direct current flows in one direction and diode allows current to flow in one direction only.

ResultsPlus
Examiner Comments

This candidate has correctly linked the two required ideas in a succinct sentence.

Question 10 (b)(ii)

Candidates found the logic of this question a little tricky, when all that was required was that the higher speed gives a higher voltage and that higher voltage will drive a higher current.

(ii) Explain how the current in the battery will change if the wind speed increases.

(2)

The current in the battery will increase, increase in wind speed causes the ~~the~~ coils to ~~th~~ cut through magnetic field lines more often so there will be more cycles and more voltage is induced causing an increase in current.

ResultsPlus
Examiner Comments

This candidate has provided a logical route to why the current is larger, in line with the mark scheme.

(ii) Explain how the current in the battery will change if the wind ~~speed~~ increases.

(2)

The current in the battery will also increase as the coil is doing more turns per second cutting the magnetic field more inducing a larger current.

ResultsPlus
Examiner Comments

This candidate did not mention voltage however they did mention the idea of the coil cutting the magnetic field more times per second.

Question 10 (c)

Candidates performed this calculation well, although a significant minority converted the time in seconds to some other unit, which was unnecessary.

Question 11 (a)

Many candidates answered a different question to the one supplied. There were many descriptions of why gases exert pressure or why that pressure may change with a change in container size or temperature.

In fact, this question was to do with the random nature of particle movement and equal probabilities of particles hitting any given wall per unit time. This is outlined in the mark scheme.

11 This question is about gas pressure.

(a) Diagram 1 shows some of the molecules of a gas in a sealed container.

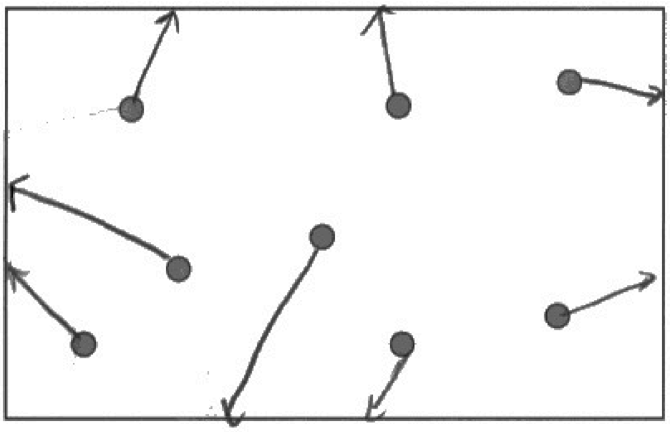


Diagram 1

The molecules collide with all the surfaces of the container. This exerts an outward force on the container and causes pressure.

Describe how the motion of the gas molecules causes an equal pressure on all the walls of the container.

You may add to diagram 1 to help your answer.

(2)

- The ~~g~~ same amount of gas particles hit the surfaces with the same force, over the same area. $p = \frac{F}{A}$, so pressure across ~~across~~ all walls is the ~~sam~~ same.

ResultsPlus
Examiner Comments

The candidate has definitely got the idea of equal numbers of particles hitting each wall, even if not referring to a rate of particle collisions. The idea of random speeds for the particles appears in the diagram, with arrows of different angles and lengths.

Question 11 (b)

This is a two-step calculation. The challenging part is to calculate the final volume of the container. Candidates usually achieved this by using ratios. After that point, provided there was a viable volume, candidates could score all three remaining marks by ECF.

(b) The width of the container is slowly decreased so that the volume of the container is smaller than before.

Diagram 2 shows the width of the container before and after this change. All other dimensions of the container remain the same.

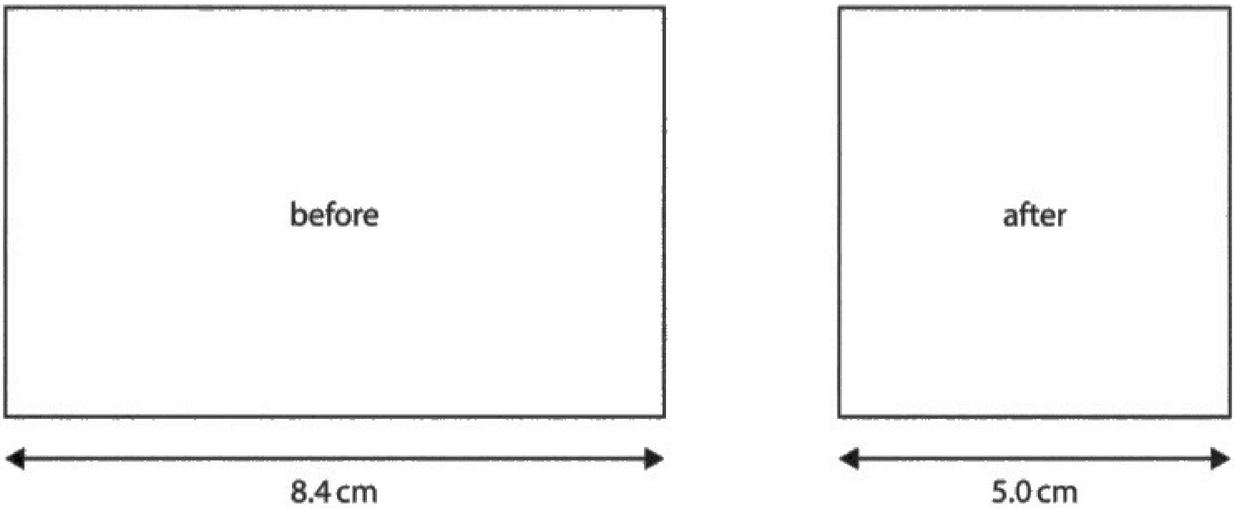


Diagram 2

The initial volume of the gas is 130 cm³.

The initial pressure of the gas is 100 kPa.

Calculate the pressure of the gas after the width of the container is decreased.

Assume the temperature of the gas remains constant.

(4)

$P_1V_1 = P_2V_2$

$100 \times 1000 = 100\,000$ Pa

$100\,000 \times 130 = P_2 V_2$

$100\,000 \times 130 = P_2 \times 77.3805$

~~$P_2 = 100\,000 \times 130$~~

$P_2 = \frac{100\,000 \times 130}{77.3805}$

$8.4 \times x = 130$

$x = 15.4761\ldots$

$15.4761 \times 5 = 77.3805$

$\frac{168000.9822}{1000} = 168.00$

$P_2 = 168000.9822$

pressure = 168 kPa

ResultsPlus
Examiner Comments

It appears that the candidate realised that this was a question on the pressure-volume relationship given on the inside front cover. On the right hand side of their response, they have provided some working to show that they know how to work out the volume of the container when it is smaller.

From there, they have continued on correctly and gone on to convert the pressure into kPa.

ResultsPlus
Examiner Tip

In this question there was no need to convert from kPa to Pa and back again. Using 100 instead of 100 000 for the initial pressure would have been perfectly satisfactory.

(b) The width of the container is slowly decreased so that the volume of the container is smaller than before.

Diagram 2 shows the width of the container before and after this change. All other dimensions of the container remain the same.

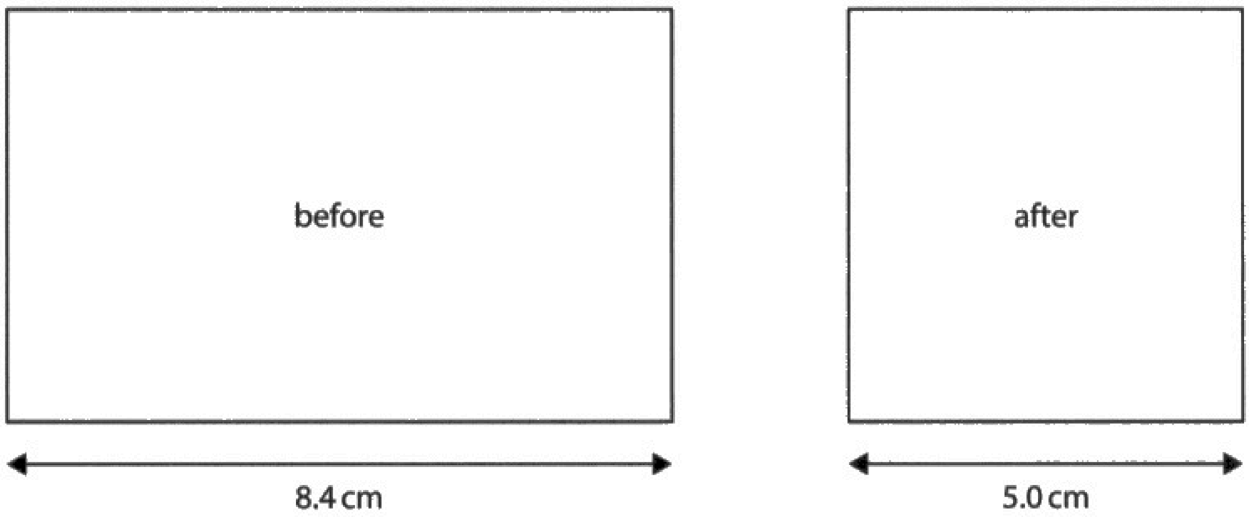


Diagram 2

The initial volume of the gas is 130 cm³.

The initial pressure of the gas is 100 kPa.

Calculate the pressure of the gas after the width of the container is decreased.

Assume the temperature of the gas remains constant.

(4)

① $\frac{8.4}{5.0} = 1.68$ S.F = 1.68

② 130 ÷ (1.68)³

= 27.4 cm³

③ $P_1 \times V_1 = P_2 \times V_2$

100 × 130 = P_2 = 27.4

$\frac{13000}{27.4} = P_2$

$P_2 = 474$

pressure = 474 kPa

ResultsPlus
Examiner Comments

In contrast, this candidate made a mistake with the new volume, possibly by assuming that the volumes were both cubic in shape.

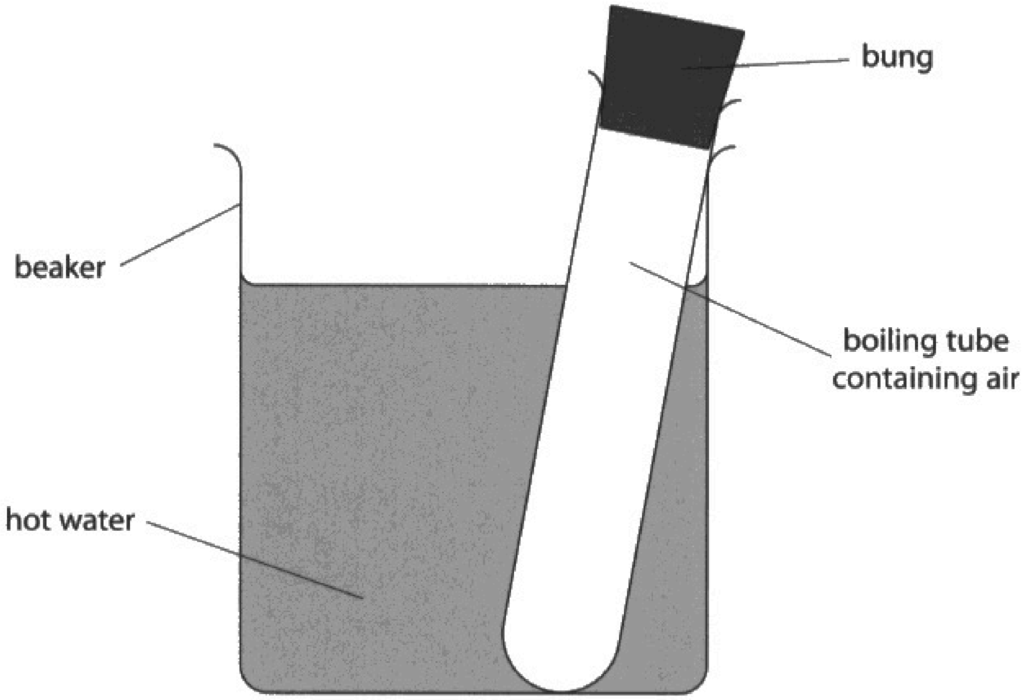
They have calculated an incorrect volume however they have gone on to complete the remaining steps correctly, scoring 3 marks ECF.

Question 12 (a)

As with any energy transfer question, recognising which value is which is crucial. The next step is then to substitute into the efficiency equation. Efficiencies cannot be greater than 100%, so the candidate is trying to find the amount of energy that when multiplied by 0.16, gives 1800 J. The candidates answered this in a number of mathematically equivalent ways, with plenty of opportunity to gain marks by being clear about what they were doing in the working.

12 Air is trapped in a boiling tube by sealing the boiling tube with a rubber bung.

The boiling tube is placed in a beaker containing hot water.



(a) Energy is transferred from the thermal store of the water to the thermal store of the air in the boiling tube with an efficiency of 16%.

The air in the boiling tube gains 1800 J of energy during this process. This is defined as the useful energy transfer.

Calculate the amount of energy wasted during this process.

(4)

16% = 1800 J

$\frac{1800}{16} = 112.5$

112.5 × 100 = 11250

11250 − 1800 = 9450

energy wasted = 9450 J

ResultsPlus
Examiner Comments

This response reflects the mark scheme closely. The candidate calculates the total amount of energy the water supplied (which clearly has to be a number larger than 1800 J). From that they subtract the useful energy transfer to determine the energy wasted: 9450 J.

ResultsPlus
Examiner Tip

This response would have been even clearer with some words to describe what it was the candidate was doing.

Question 12 (b)

Candidates provided a wide range of suggestions, many of which satisfied at least one marking point.

(b) Give two ways that the apparatus could be modified to improve the efficiency of the energy transfer.

(2)

add insulator around the beaker,

add a lid to the beaker

ResultsPlus
Examiner Comments

This candidate provides two suggestions that fulfil the criteria in the mark scheme in a clear, concise way.

ResultsPlus
Examiner Tip

Answers to questions even this late in the paper can still be brief and to the point whilst still being perfectly correct.

Paper Summary

Based on their performance on this paper, candidates should:

- Take care when drawing diagrams to add labels and draw accurately. To do this, they should be familiar with the names of standard apparatus used in different branches of physics.
- Ensure that they have either seen or performed the practicals named in the specification where possible. This includes either building or simulating circuits in which the number of components changes and noting the effect on the currents and voltages in or across those components.
- 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 or any specific instructions used in each question to determine how the examiner expects the question to be answered, for instance whether to give a description, an explanation or to use a particular idea ie forces.
- Be familiar with the equations listed in the specification and be able to use them confidently.
- Structure multi-step calculations as simply as possible to facilitate checking at each stage.
- Recall the units given in the specification and use them appropriately, for instance resistance.
- Practise structuring and sequencing longer extended writing questions.
- Show all working so that some credit can still be given for answers that are only partly correct.
- Allow time at the end of the examination to check answers carefully and correct basic slips in wording or calculation.

Grade boundaries

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