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Examiners' Report
June 2023

Int GCSE Physics 4PH1 2P

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June 2023

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Introduction

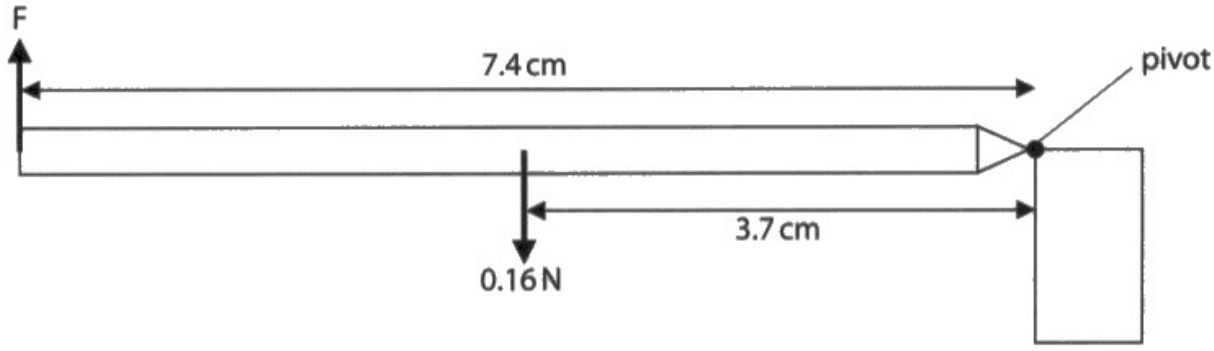
As in examinations for previous series, most candidates were able to either recall or use the extra formula sheet effectively. More often than not, they handled the related calculations well. Candidates who gave the best practical descriptions usually appeared to be writing from first-hand experience. While it may be possible to only use simulations online for some or all of these investigations, there is the "Guide for core practicals" on the Pearson IGCSE Physics webpage, in the "Teaching and Learning" section.

Responses to the longer questions showed that the less able candidates tended to struggle when assembling a logical description, when asked to offer more than one idea or when asked to link evidence with ideas. This is particularly prevalent in questions about astrophysics, magnetic induction and nuclear physics. There is an excellent guide to astrophysics in the topic support section of the aforementioned webpage. That said, there were a wide range of responses, enabling all candidates to show what they could do. It was pleasing to see that many candidates could give full and accurate answers.

Question 1 (b)

Over half of all candidates completed this item perfectly. A small minority calculated the moment in Q01(b)(i) and could go no further. The most common misconception was that the moment required for Q01(b)(ii) was zero or some number that was different to that calculated in Q01(b)(i). 'State' questions require no further calculation, although a reasonable fraction of candidates re-calculated the moment or made an error in transcription.

(b) The diagram shows the pencil with one end resting on a small block.



A finger provides an upwards force, F, to keep the pencil horizontal.

(i) The weight of the pencil is 0.16 N.

Calculate the moment of the weight of the pencil about the pivot.

Use the formula

moment = force × perpendicular distance from the pivot

(2)

i 0.16 x 3.7

moment = 0.592 N cm

(ii) State the moment of the force F.

(1)

0.16 x 7.4
=1.184

moment = 1.18 Ncm

(iii) Show that force F is 0.080 N.

(2)

0.16 x 3.7 = F x 7.4

0.592 ÷ 7.4 = 0.080 N

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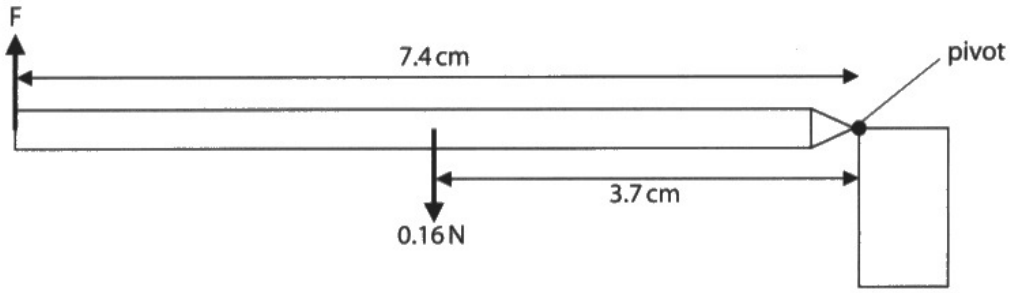
Examiner Comments

Q01(b)(i) has gone well. The candidate has not linked their answer for Q01(b)(i) to the answer to Q01(b)(ii). Q01(b)(iii) is a standard calculation, which they have attempted from first principles, which was perfectly acceptable.

ResultsPlus
Examiner Tip

Read the question all the way through as items in the same sub-question (eg Q01(b)) are related. It may save some time and effort to realise that these parts are linked.

(b) The diagram shows the pencil with one end resting on a small block.



A finger provides an upwards force, F, to keep the pencil horizontal.

(i) The weight of the pencil is 0.16 N.

Calculate the moment of the weight of the pencil about the pivot.

Use the formula

moment = force × perpendicular distance from the pivot

(2)

0.16 × ~~7.4~~ 3.7 = ~~1.184~~ 0.592

moment = ~~1.184~~ 0.592 N cm

(ii) State the moment of the force F.

~~0.16 × 7.4 = 1.184~~

(1)

moment = ~~1.184~~ 0.592 N cm

(iii) Show that force F is 0.080 N.

(2)

0.592 = F × 7.4

÷ 7.4 ÷ 7.4

0.080 = F

ResultsPlus
Examiner Comments

This candidate answered the question exactly as intended. The question has guided them through, including to the final part, Q01(b)(iii), where the total moment is equated to the moment of force F.

Question 2 (a)

A large majority of candidates found it straightforward to communicate the dual ideas of fixed particles that are vibrating. Those that did not tended to not verbalise the idea of the particles being fixed sufficiently clearly.

2 A solid bar of chocolate is taken from a refrigerator.

(Source: © MarySan/Shutterstock)

(a) The temperature of the chocolate bar is 5 °C.

Describe the arrangement and motion of the particles inside the chocolate bar.

(2)

The particles are in a structure and they are vibrating.

ResultsPlus
Examiner Comments

In a structure here is too vague. There should be a reference to 'fixed', 'regular' or 'uniform'.

2 A solid bar of chocolate is taken from a refrigerator.

(Source: © MarySan/Shutterstock)

(a) The temperature of the chocolate bar is 5 °C.

Describe the arrangement and motion of the particles inside the chocolate bar.

(2)

particles are in neatly arranged, regular rows in fixed positions and are vibrating.

ResultsPlus
Examiner Comments

This candidate has made it as clear as possible that they know that the particles are vibrating and are in some sort of fixed positions.

Question 2 (b)(i)

Very large numbers of candidates discussed the idea of the particles no longer being in fixed positions in one of an array of different ways. Rather more challenging was the notion of random motion. As this question was specifically about the motion, comments about bonds, spacing or arrangements were ignored.

(b) The chocolate is heated at a constant rate until the temperature reaches 45 °C.

The chocolate has a melting point of 32 °C and a boiling point of 55 °C.

(i) Describe the motion of the particles in the chocolate when the chocolate is at a temperature of 45 °C.

(2)

At 45°c, the particles have started to separate, as they are now moving around due to the increase in energy they recive, this mae movement causes the ~~chocl~~ chocolate to be a liquid

ResultsPlus Examiner Comments

"Moving around" in the second line was sufficient to satisfy the idea that the particles are no longer in fixed positions. "Energy" without a reference to kinetic energy was not sufficient. There is no sense that the motion is random. 1 mark awarded.

ResultsPlus Examiner Tip

Check to make sure that you are not providing an answer that is not required.

(b) The chocolate is heated at a constant rate until the temperature reaches 45 °C.

The chocolate has a melting point of 32 °C and a boiling point of 55 °C.

(i) Describe the motion of the particles in the chocolate when the chocolate is at a temperature of 45 °C.

(2)

- Particles can slide over each other
- Move in random directions
- Still close to each other.

ResultsPlus
Examiner Comments

In contrast, this candidate has been concise and precise with their answer. 2 marks awarded.

ResultsPlus
Examiner Tip

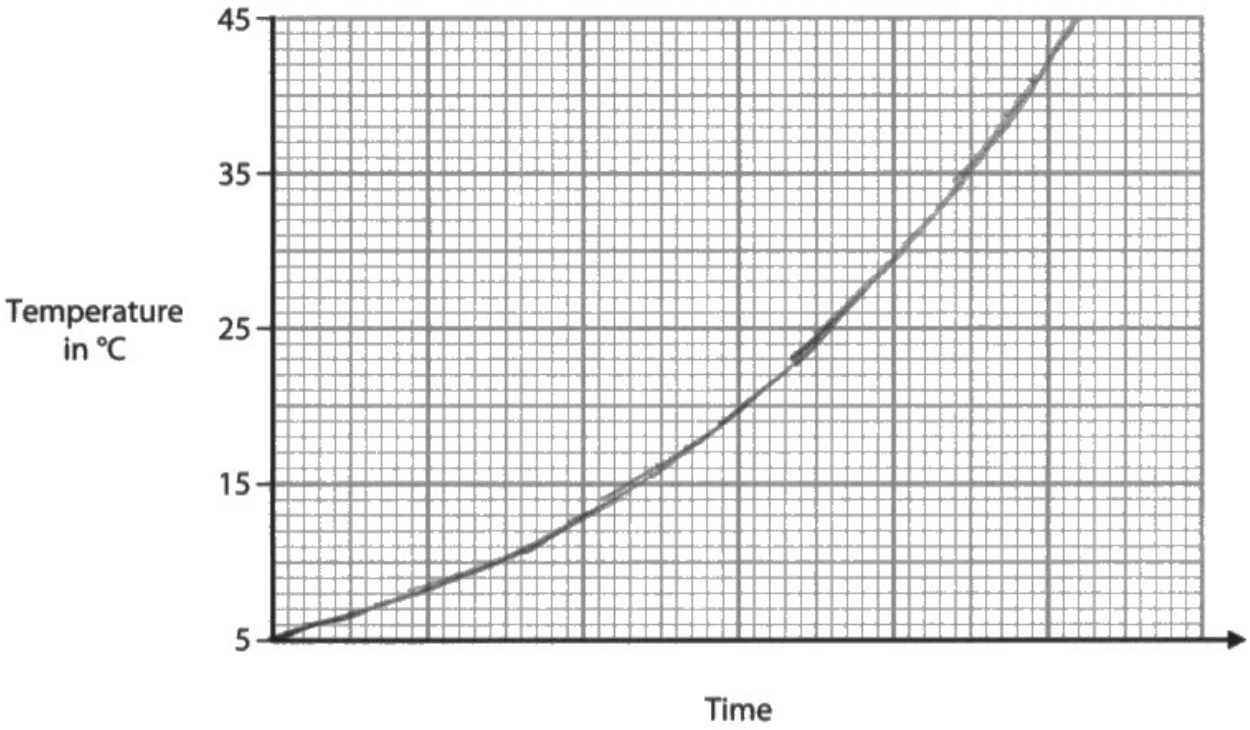
Bullet points are perfectly acceptable for description and explanation questions. There are no extra marks available for quality of written communication on the specification currently.

Question 2 (b)(iii)

Candidates did very well transcribing their ideas into graphical form. Most spotted that the graph requires a flat section, denoting where the chocolate was melting and that the temperature should rise from 5 to 32 degrees and then again from 32 degrees to 45 degrees (corresponding to the bottom and top of the scale on the y-axis). A small number of candidates put the flat portion at a temperature other than 32 degrees by misreading the scale. The most common misunderstanding was to omit the flat portion ie that the chocolate went from 5 to 45 degrees without interruption.

(iii) Use the axes to sketch a graph of how the temperature of the chocolate changes with time when it is heated from 5 °C to 45 °C.

(3)

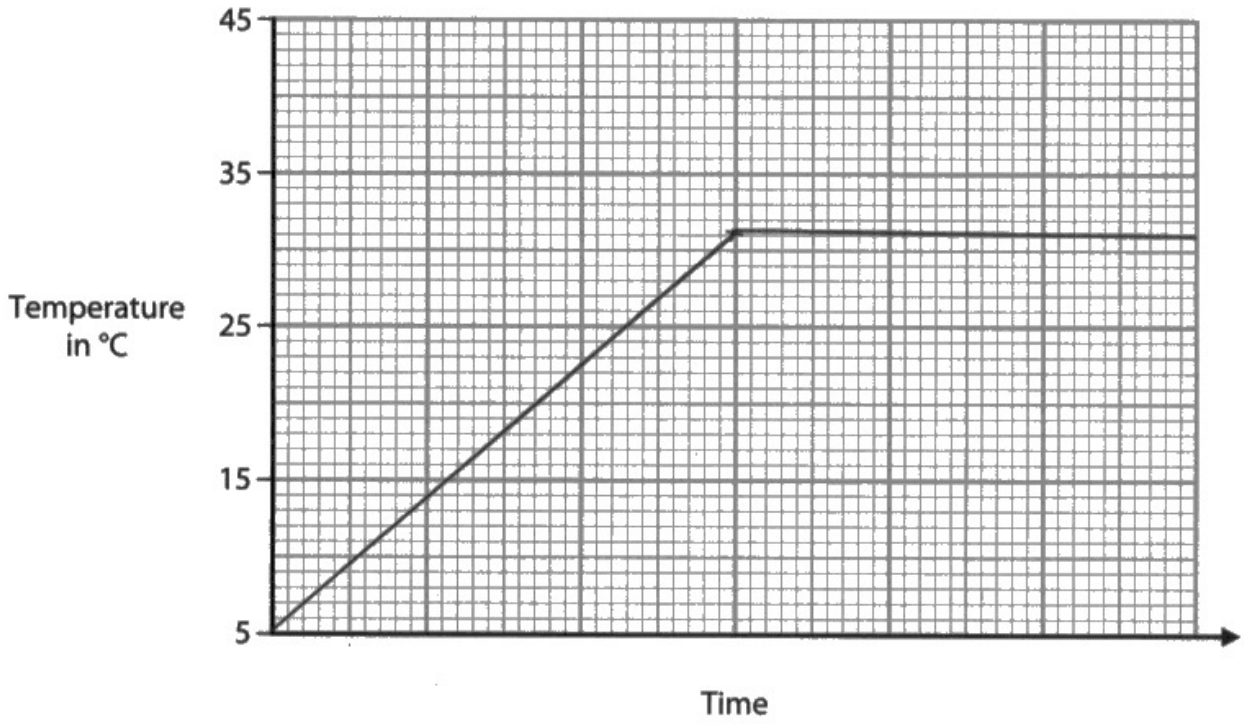


ResultsPlus
Examiner Comments

Curved lines were acceptable. This response scored 1 mark only for starting and finishing at the correct temperatures.

(iii) Use the axes to sketch a graph of how the temperature of the chocolate changes with time when it is heated from 5 °C to 45 °C.

(3)



(Total for Question 2 = 8 marks)

Melting Point = 32°

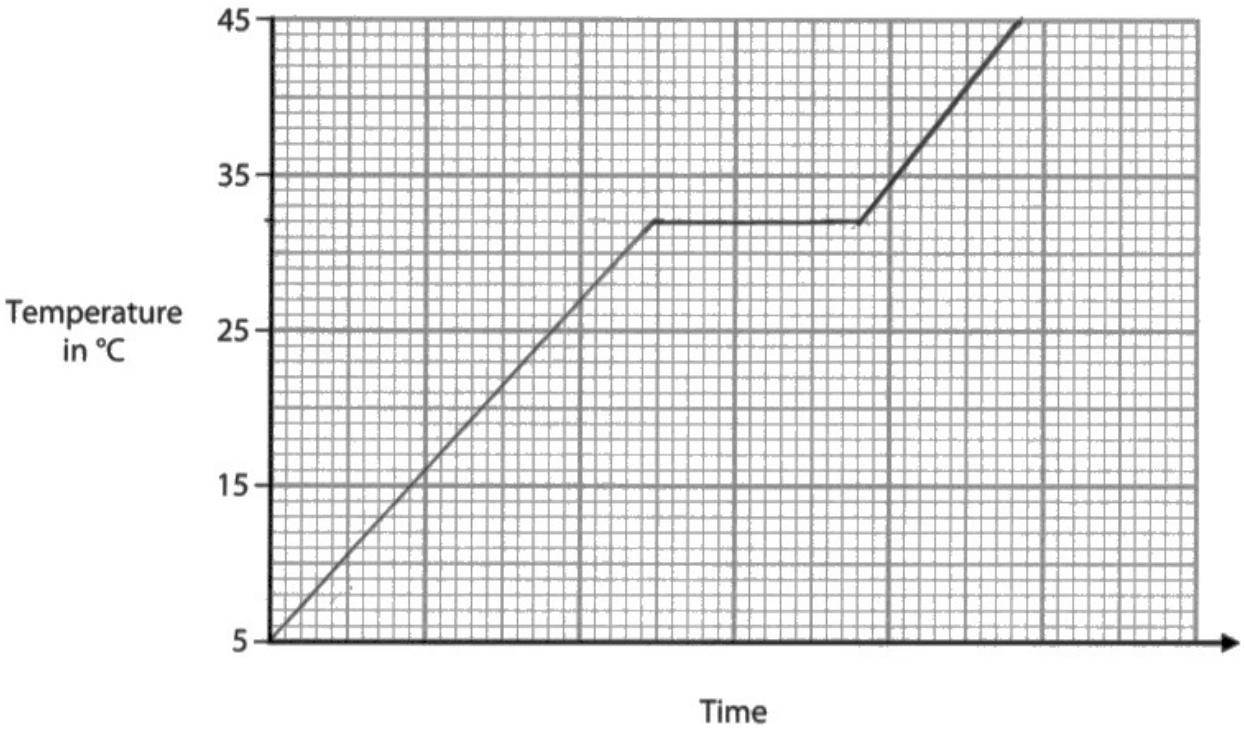
Boiling Point = 55°

ResultsPlus
Examiner Comments

This response unfortunately only scores 1 mark because it doesn't finish at 45 degrees. The flat portion is otherwise correct.

(iii) Use the axes to sketch a graph of how the temperature of the chocolate changes with time when it is heated from 5 °C to 45 °C.

(3)



ResultsPlus
Examiner Comments

This response is excellent, incorporating all the required features.

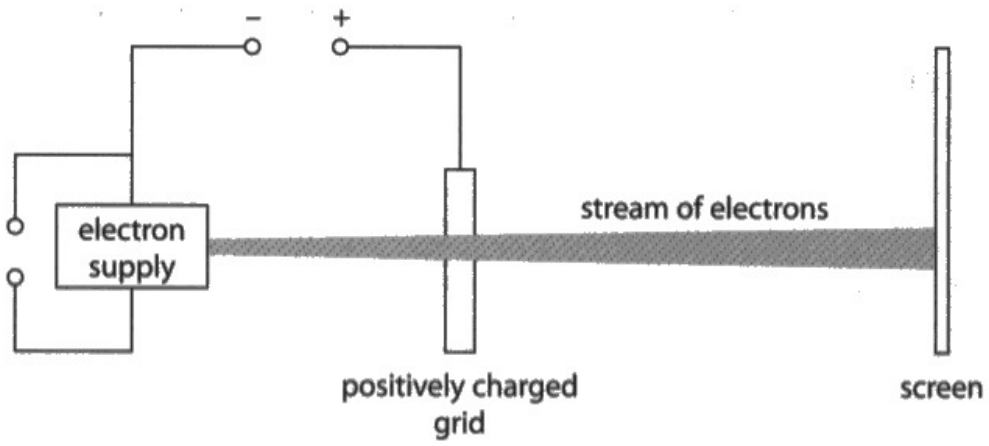
Question 3 (a)(i)

Candidates appeared to either know this well or not at all, with a roughly even split between 0 and 2 marks awarded. Candidates should remember that in solids, changes in charge can only be achieved by the transfer of electrons, specification point 2.24P.

3 The diagram shows the inside of an oscilloscope.

Electrons leave the electron supply and accelerate towards the screen.

The stream of electrons hits the screen.



(a) The grid is connected to the positive terminal of a high voltage power supply.

(i) Explain, in terms of the movement of particles, how the grid has become positively charged.

(2)

The grid loses electrons which means there there are more positive protons than negative electrons which gives the grid a positive charge.

ResultsPlus
Examiner Comments

The candidate has expanded on the required knowledge here, providing a little more content to their answer. This wasn't necessary here: the first four words would have been sufficient.

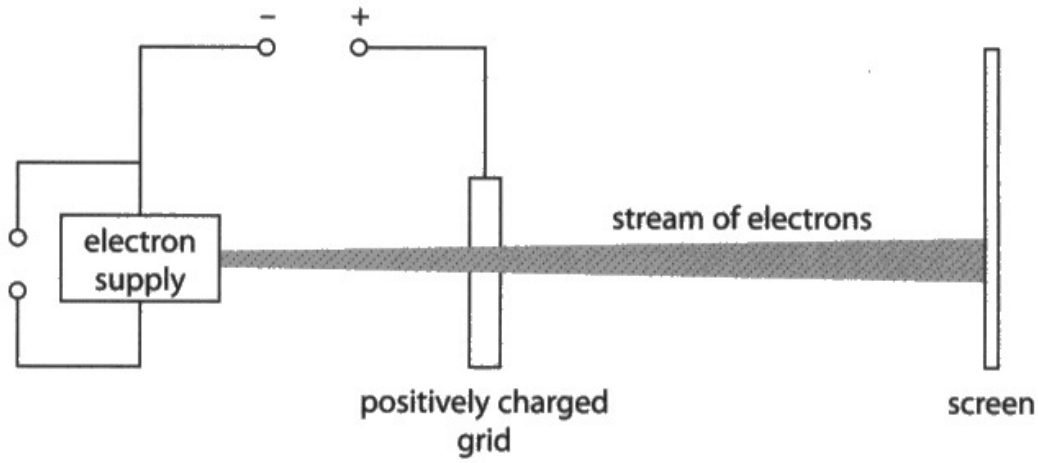
ResultsPlus
Examiner Tip

Sometimes further expansion is required. Early on in the paper, this is unlikely.

3 The diagram shows the inside of an oscilloscope.

Electrons leave the electron supply and accelerate towards the screen.

The stream of electrons hits the screen.



(a) The grid is connected to the positive terminal of a high voltage power supply.

(i) Explain, in terms of the movement of particles, how the grid has become positively charged.

(2)

All the positives ions from the cell are attracted to the grid and make the grid positively charged.

ResultsPlus
Examiner Comments

Movement of positive ions cannot be correct in this instance. It might be the case in chemistry for battery's and cells, for example.

Question 3 (a)(ii)-(a)(iii)

Well over half of the candidates completed this question perfectly which is excellent. A small minority of candidates could not substitute the values into the correct places in the formula. By far the most common errors were forgetting to take the square root or by making some sort of error with standard form.

(ii) State the formula linking kinetic energy, mass and speed.

(1)

Kinetic energy = $\frac{1}{2}$ x mass x speed^2

(iii) Calculate the speed of an electron when it has 1.3×10^{-15} J of kinetic energy.

The mass of an electron is 9.1×10^{-31} kg.

(3)

$1.3 \times 10^{-5} = \frac{1}{2} \times 9.1 \times 10^{-31} \times ?^2$

$\frac{1}{2} \times 9.1 \times 10^{-31} \div 1.3 \times 10^{-5} = 2.857142857 \times 10^{25}$

speed = 2.86×10^{25} m/s

ResultsPlus
Examiner Comments

This candidate has got the formula correct and substituted in the correct places.

The charge has the wrong power of ten, which would have given an acceptable answer for 2 marks, however the candidate has omitted the square root as well. 1 mark awarded for Q03(a)(iii).

ResultsPlus
Examiner Tip

Never use double-headed arrows. It is impossible to decide which way around your intentions are.

(ii) State the formula linking kinetic energy, mass and speed.

(1)

kinetic energy = $\frac{1}{2}$ × mass × (speed)^2

(iii) Calculate the speed of an electron when it has 1.3×10^{-15} J of kinetic energy.

The mass of an electron is 9.1×10^{-31} kg.

(3)

$1.3 \times 10^{-15} = \frac{1}{2} \times (9.1 \times 10^{-31}) \times (\text{speed})^2$

$\Rightarrow (\text{speed})^2 = 2.86 \times 10^{15}$

$\text{speed} = \sqrt{2.86 \times 10^{15}}$

speed = 53450000 m/s

5.4 × 10^7

ResultsPlus
Examiner Comments

This candidate has done an excellent job of presenting their work in a clear, logical and exemplary way.

Unfortunately, they have made an error in rounding on the answer line, the answer should be 5.3 x 10^7 m/s. 2 marks awarded.

ResultsPlus
Examiner Tip

Please check your rounding.

Question 3 (b)

A large proportion of the candidates repeated the idea that like charges repel. A small fraction did not make it clear that they knew that all the particles were the same charge and so scored 1 mark only.

(b) The stream of electrons spreads out as it travels towards the screen.

Explain why the electrons in the stream move apart from each other.

(2)

b) like charges repel so the electrons will move away from one another.

ResultsPlus
Examiner Comments

This candidate did not make it clear they knew the electrons were all the same charge. Whilst relatively obvious as part of an explanation it should be clearly stated.

(b) The stream of electrons spreads out as it travels towards the screen.

Explain why the electrons in the stream move apart from each other.

(2)

Because ~~they~~ they're all negatively charged and ~~like like~~ charges repel. like charges repel

ResultsPlus
Examiner Comments

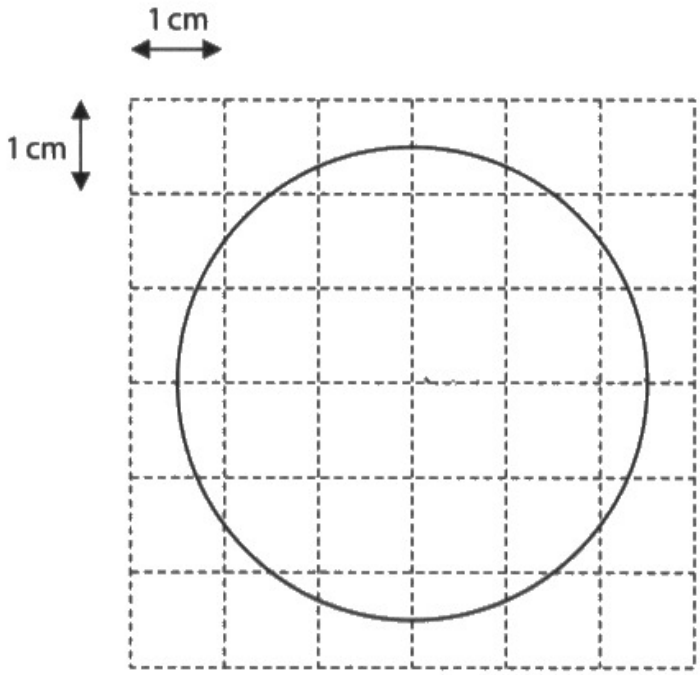
This candidate has made both required parts of the explanation as clear as possible, so received 2 marks.

Question 3 (c)

Almost all candidates measured the radius of the circle correctly although a tiny minority quoted the value for the diameter. The calculation went well, with the most common pitfall being the conversions to base units. Errors in formula manipulation were unusual.

(c) The oscilloscope can cause the electrons to move in a circle.

This produces a circular pattern on the screen.



(i) Use the scale to determine the **radius** of the circle.

(1)

radius = 2.4 cm

(ii) The time taken for the electrons to complete one orbit of the circle is 24 ms.

Calculate the orbital speed of the electrons.

Use the formula

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}}$$

(3)

$$\frac{2\pi (2 \cdot 4)}{24 \times 10^{-3}}$$

$$= 628.3185$$

orbital speed = 628.32 m/s

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Examiner Comments

This candidate has measured the diameter of the circle and halved that to arrive at an acceptable radius in Q03(c)(i).

In Q03(c)(ii), they have substituted into the given formula correctly and performed the calculation successfully, including converting the milliseconds into seconds. Their only error is to have forgotten the conversion from cm to m.

If they had altered the m/s to cm/s on the answer line they would have scored all three marks for this calculation. As it stands, they achieved 2 marks.

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Examiner Tip

Check the prefix on all values to be substituted into a formula.

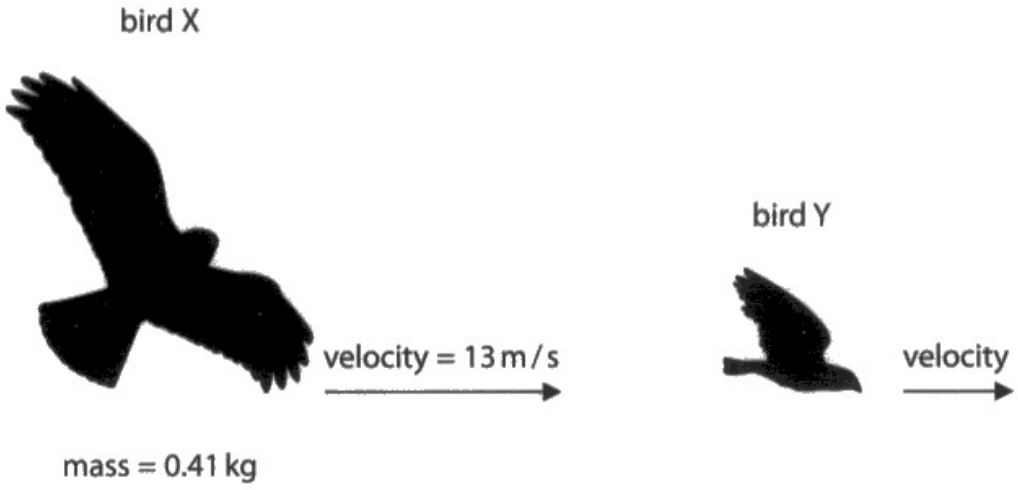
Question 4

Approximately half of all candidates completed this question with all its parts perfectly. There were a number of acceptable alternatives for the answer in Q04(b), which meant an equal number of acceptable alternatives for the answer to Q04(d). Equally, candidates could derive the correct from first principles, ignoring the first three parts of the question, in a similar way to the end of Q01.

If a candidate was likely to make a minor error, it was in presuming there was a calculation to perform for Q04(c) when in fact, the question is trying to guide the candidate through a multiple-step calculation. That calculation often involved subtracting the momentum of the small bird. This applied also to candidate's answers for Q04(b).

4 The diagram shows two birds, just before bird X catches the smaller bird Y.

Both birds are travelling horizontally at constant velocity.



(a) Show that the momentum of bird X is about 5 kg m/s.

(2)

momentum = mass x velocity

0.41 x 13

= 5.33 m/s

(b) The momentum of bird Y just before it is caught is 0.15 kg m/s.

Calculate the total momentum of the birds just before bird X catches bird Y.

(1)

momentum = 5.15 kg m/s

(c) State the total momentum of the birds just after bird X has caught bird Y.

(1)

momentum = 5.15 kg m/s

(d) Bird Y has a mass of 0.17 kg.

Calculate the velocity of the birds just after bird X has caught bird Y.

(3)

Velocity = ~~mass~~ momentum / mass

$$\frac{5.15}{0.41+0.17}$$

$$= 8.87431$$

velocity = 8.88 m/s

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Examiner Comments

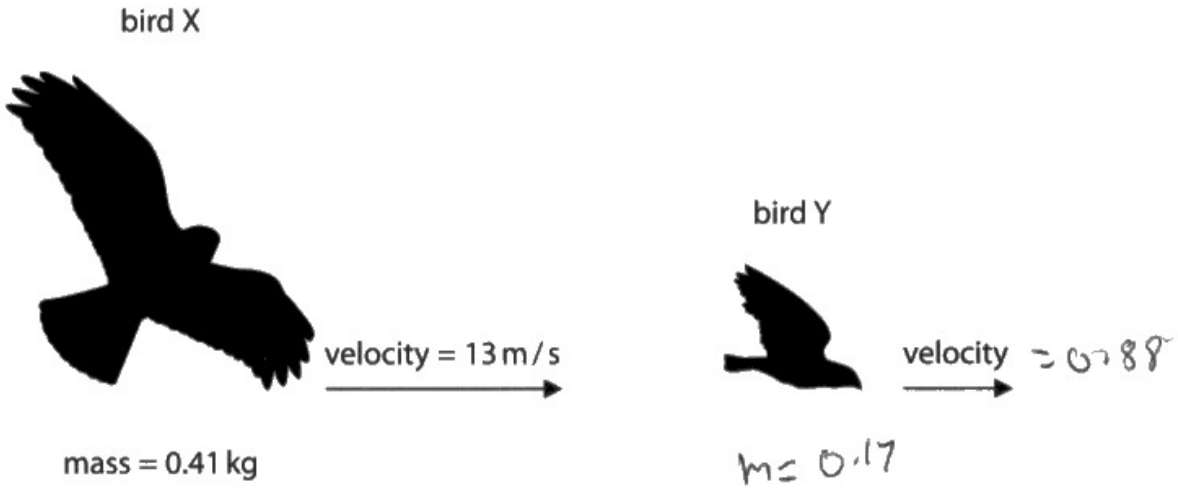
While the candidate appears to have done something strange for Q04(b) and Q04(c), they have done something sensible by using the value of 5 kg m/s provided for them in Q04(a). After that point the candidate has completed the tasks successfully, scoring full marks for the whole question.

ResultsPlus
Examiner Tip

Using a given value, rather than your calculated value is perfectly acceptable and, in the case when you don't trust your calculated value, a sensible strategy.

4 The diagram shows two birds, just before bird X catches the smaller bird Y.

Both birds are travelling horizontally at constant velocity.



(a) Show that the momentum of bird X is about 5 kg m/s.

(2)

$p = mv$

$0.41 \times 13 = 5.33 \approx 5$

(b) The momentum of bird Y just before it is caught is 0.15 kg m/s.

Calculate the total momentum of the birds just before bird X catches bird Y.

(1)

$5.33 + 0.15$

momentum = 5.48 kg m/s

(c) State the total momentum of the birds just after bird X has caught bird Y.

(1)

5.48

momentum = ~~5.33~~ kg m/s

(d) Bird Y has a mass of 0.17 kg.

Calculate the velocity of the birds just after bird X has caught bird Y.

(3)

0.15 / 0.17 = 0.88 m/s birdy

$\frac{5.33}{0.58} = 9.18$

0.17 + 0.41 = 0.58

velocity = 9.18 m/s

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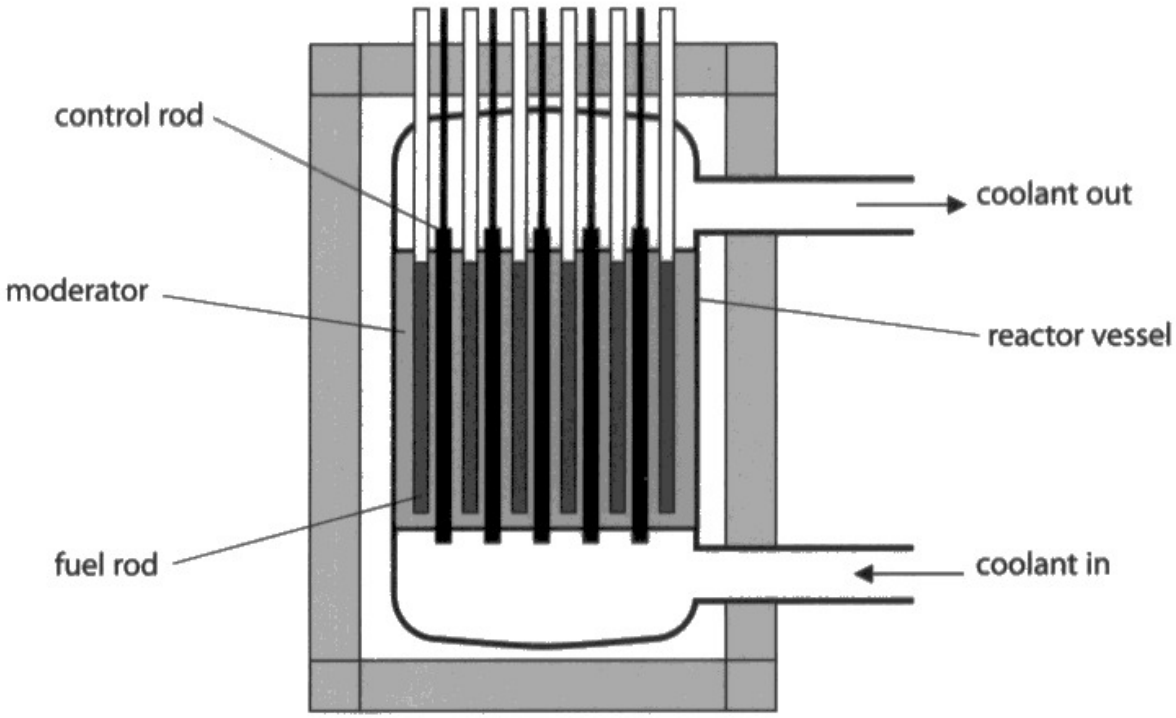
Examiner Comments

This candidate has completed the first three parts of this question perfectly. Their error is in Q04(d) – they have used the momentum of the large bird **before** the 'collision' rather than the **total** momentum **after** the 'collision'.

Question 5 (a)

Candidates usually find the idea on test here challenging. Although the basic principles are evident, the technical language is very important. This is a question about nuclear physics so candidates should talk about the effect on and splitting of a nucleus, rather than an atom, a molecule or a particle. The initial neutron is **absorbed** although **combined with** is a suitable alternative. Despite these challenges, exactly half of all candidates scored at least a mark, with progressively smaller fractions gaining 2 or 3 marks.

5 The diagram shows some of the components of a nuclear fission reactor.



(a) Describe how a chain reaction occurs in a nuclear fission reactor.

(3)

A neutron is collided with an atom, eg a uranium atom. This causes the atom to split into two daughter nuclei and two neutrons. One of these neutrons goes on to collide with another uranium atom while one is absorbed by boron in the moderator.

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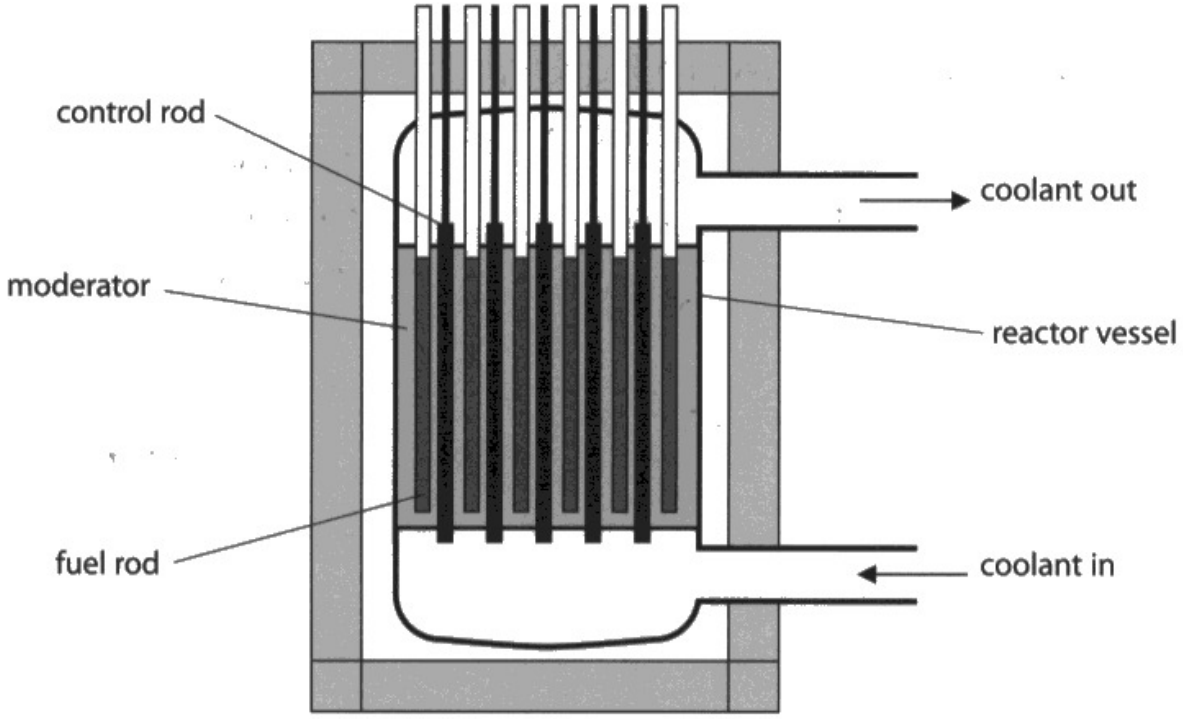
Examiner Comments

In basic terms, this response is on the right lines. Unfortunately it scores zero, because of the wholly inaccurate language. The nucleus is referred to as an atom all the way through. The neutron also 'is collided with' the atom rather than the more accurate 'absorbed by' the nucleus.

ResultsPlus
Examiner Tip

The requirement for correct terminology is increasingly important throughout the paper.

5 The diagram shows some of the components of a nuclear fission reactor.



(a) Describe how a chain reaction occurs in a nuclear fission reactor.

(3)

nucleus absorbs a neutron

unstable nucleus splits into two smaller nuclei

two or three neutrons also emitted

which can be absorbed by another nucleus

the nucleus will split and this process repeats

emit two or three neutrons

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Examiner Comments

The ideas are similar in this response, compared with the previous response. The technical language is far superior, however. 3 marks awarded.

Question 5 (b)

Well over half of all candidates scored at least a mark on this item. The question was about the function of the control rods, rather than the material they may be made from, which many candidates relied upon for credit. Of course the primary function is to absorb neutrons, which many candidates stated. The second mark was more challenging, however, although there were four viable alternatives.

(b) Describe the role of the control rods in a nuclear fission reactor.

(2)

- Absorbs nuetrons.
- Made out of Boron.
- Allows the Chain reaction to be monitored minimising the likelyhood of a radioactive explosion.

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Examiner Comments

There is a clear reference to neutron absorption. The last bullet point is a 'near-miss', however it didn't include enough correct physics for the second mark to be awarded.

(b) Describe the role of the control rods in a nuclear fission reactor.

(2)

control rods are made from Boron and absorb neutrons. This means when the control rods are fully in the reactor they absorb neutrons and prevent them from being absorbed by ~~neutrons~~ nuclei, preventing fission and ~~stopp~~ slows down the reaction.

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Examiner Comments

This response is perfect. The candidate refers to the absorption of neutrons and why that is important in a fission reactor.

Question 5 (c)

Very few candidates muddled the ideas of fission and fusion. Well over half provided descriptions that included perfect technical language or acceptable alternatives to score both marks.

(c) Describe how the process of nuclear fission is different from the process of nuclear fusion.

(2)

In nuclear fission, the nuclei divide to form daughter nuclei. In nuclear fusion, the nuclei combine to create a bigger nucleus.

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Examiner Comments

The language here is just about acceptable. The candidate refers to nucleus/nuclei – we condoned imprecise singular/plural of this word – and used reasonable verbs. 2 marks awarded.

Question 5 (d)(ii)

This single mark proved moderately difficult. The successful candidates referred to the repulsion between the positive charges of the nuclei.

(ii) Give a reason why the nuclear process in stars does not happen at low temperatures and pressures.

(1)

- nuclear fision can only occur at very high temperatures and pressures

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This candidate did not score the mark as they have merely negated the question, rather than provide an additional reason.

(ii) Give a reason why the nuclear process in stars does not happen at low temperatures and pressures.

(1)

because the two positive nuclei need to get really close and they will repell so large amount of energy is needed.

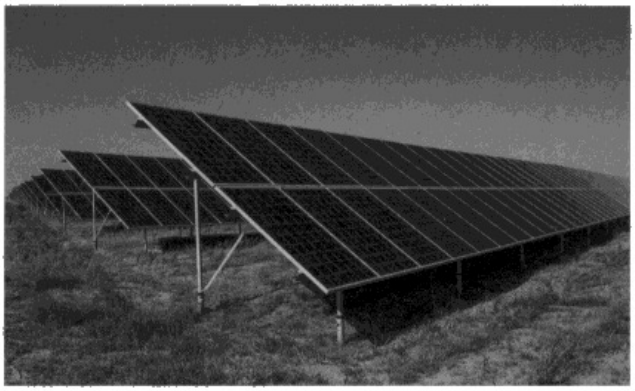
ResultsPlus Examiner Comments

This candidate has gone one step further than the previous candidate, offering a reason beyond merely a negation of the statement. They have used an additional idea from the specification, hence scoring the mark.

Question 6 (a)(i)

Candidates found this item moderately difficult. More often than not, they correctly mentioned the effect of the step-up transformer on the current. We ignored references to the effect on the voltage as it is the current that causes the heating effect. The second mark was more challenging to achieve. There needed to be some element of comparison between the heating loss from both low current and high current transmission ie a lower energy loss with a higher current.

6 The National Grid is used in the United Kingdom for the large-scale transmission of electricity. The photograph shows solar panels connected to the National Grid.



(Source: © Jenson/Shutterstock)

(a) Solar panels provide direct current to a device that outputs an alternating current so that the energy from the solar panels can be supplied to the National Grid.

(i) Explain why a step-up transformer is used to supply the National Grid.

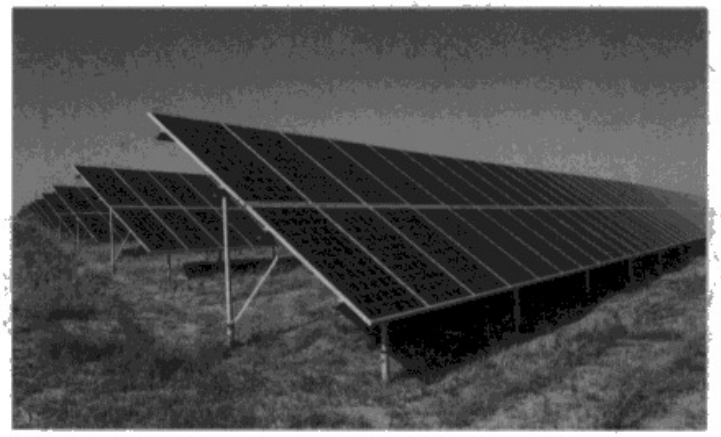
(2)

Step up transformers increase voltage during transmission so ~~use~~ current decreases during transmission. This means little energy is lost in the cables, maximising the amount of electricity that can be distributed in the national grid.

ResultsPlus
Examiner Comments

This candidate is very nearly there for both marks. They have mentioned the reduction in current. The reference to 'low energy' or 'more electricity' is insufficient for the second mark. 1 mark awarded.

6 The National Grid is used in the United Kingdom for the large-scale transmission of electricity. The photograph shows solar panels connected to the National Grid.



(Source: © Jenson/Shutterstock)

(a) Solar panels provide direct current to a device that outputs an alternating current so that the energy from the solar panels can be supplied to the National Grid.

(i) Explain why a step-up transformer is used to supply the National Grid.

(2)

It is more effiecent to transport energy at a high voltage so a step-up transformer is used so less energy is lost due to resistance of wires. step-up transformer increases ~~voltage~~ voltage and decreases current.

ResultsPlus
Examiner Comments

This candidate has made it clear in their first sentence that they understand the implications of a lower current with the reference to 'less energy is lost'. The second sentence scores the first marking point. 2 marks in total.

Question 6 (a)(ii)-(a)(iii)

Despite the large numbers and the "kilo" prefix on the voltage, a very large majority of candidates scored all of the marks available. Any errors were broadly mathematical in nature such as poor formula manipulation, mis-substitution or dropping a zero when typing numbers into a calculator.

(ii) This is the label on the step-up transformer.

input voltage = 15 kV
output voltage = 340 kV
number of turns on primary coil = 1400

State the formula linking input voltage, output voltage and turns ratio for a transformer.

$$\frac{\text{input volt}}{\text{output volt}} = \frac{\text{Primary turns}}{\text{secondary turns}}$$ (1)

(iii) Calculate the number of turns on the secondary coil of the step-up transformer.

(3)

$$\frac{15}{340} \times 1400 = 61.764705882$$
$$61.8$$

number of turns = 61.8

ResultsPlus
Examiner Comments

Answers rounding to 62 were the most common incorrect answer. The candidate has not shown their substitution (which would have scored them a mark) and they have made an error in re-arrangement. 0 marks awarded.

ResultsPlus
Examiner Tip

Always put the numbers into the formula to show you know where each number goes as this is often worth a mark by itself.

Practise using three numbers to calculate the missing fourth number eg select an input voltage, an output voltage and number of primary turns then calculate the number of secondary turns. Then try again trying to find the number of primary turns from the voltages and a given number of secondary turns.

A technique known as **cross-multiplication** may be helpful.

(ii) This is the label on the step-up transformer.

input voltage = 15 kV
output voltage = 340 kV
number of turns on primary coil = 1400

State the formula linking input voltage, output voltage and turns ratio for a transformer.

$\frac{\text{input (primary voltage)}}{\text{output secondary (voltage)}} = \frac{\text{primary turns}}{\text{secondary turns}}$ (1)

(iii) Calculate the number of turns on the secondary coil of the step-up transformer.

(3)

$\frac{15}{340} = \frac{1400}{x}$

$15x = 47600$

$x = \frac{47600}{15} = 3173$

number of turns = 3173

ResultsPlus
Examiner Comments

This candidate has performed the substitution and manipulation perfectly. Unfortunately they have either transcribed the number from their calculator incorrectly or have typed the numbers into the calculator incorrectly. Most likely it was a missing 'zero' at the end of 1400 or 340. This has caused a **power of ten** error, resulting in a one mark penalty. 2 marks scored for Q06(a)(iii).

Question 6 (b)

This item was the second most challenging item on the paper. Candidates told us all about a.c. without referring to d.c. at all, whereas the question specifically asks for why the transformer would not work with d.c. This caused about two-thirds of candidates to score zero. Candidates that satisfied the high demand of this item fared better by mentioning about constant current giving a constant magnetic field or by stating that using constant current could not induce a voltage, which scored a mark or two.

(b) Solar panels produce constant direct current (d.c.).

Explain why a transformer will not work when connected to constant direct current.

(3)

Direct current only flows in one direction so will not produce an alternating magnetic field. The magnetic field then won't be able to reach the secondary coil and transfer the power. A voltage can't be induced so no power would be transferred to the secondary coil the magnetic iron core won't be magnetised as only alternating current can magnetise it so the current won't be transferred either to the secondary coil

ResultsPlus
Examiner Comments

This candidate is very nearly there for all three marks. The first marking point is in the first two lines and the third marking point is in line 4. The technical language isn't apparent for the second marking point unlike the next response. Indeed, there is reference to the field 'not reaching the secondary coil', which isn't true. 2 marks awarded.

(b) Solar panels produce constant direct current (d.c.).

Explain why a transformer will not work when connected to constant direct current.

(3)

- d.c only travel in one direction
- No alternating magnetic field
- ~~No cutting~~ ~~the don't~~ Secondary coil don't cut ~~with~~ the magnetic field lines
- No voltage is induced in the secondary coil.
- Therefore no current in secondary coil

ResultsPlus
Examiner Comments

This candidate did an excellent job. Again, they have used bullet points to be as concise and as clear as possible. While the language isn't perfect, the crucial ideas are all there. 3 marks awarded.

Question 7 (a)(i)

The only acceptable answer here was 'protractor'. As ever we accepted recognisable spellings.

Question 7 (a)(ii)-(a)(iv)

A very large majority of candidates scored full marks on this item. Common misconceptions include missing the 'sin' out of the refractive index formula (although this was rarer than in previous years) thus simply dividing the angles to get a number that could well be a legitimate refractive index.

(ii) Measure the angle of incidence and the angle of refraction for the light entering the prism.

(2)

$90 - 63 = 27^0$

angle of incidence = 44 degrees

angle of refraction = 27 degrees

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

(1)

$n = \frac{\sin(i)}{\sin(r)}$

(iv) Calculate the refractive index of the glass.

(2)

$n = \frac{\sin(44)}{\sin(27)}$ $n = \frac{\sin(i)}{\sin(r)}$

$n = 1.53 (3\text{sf})$

refractive index = 1.53 (3 sf)

ResultsPlus
Examiner Comments

This answer is perfect. The working is clear and careful, leading to a solution worthy of full marks.

There is a suggestion that the candidate re-checked their answer by calculating the angle of refraction using the formula and refractive index found in Q07(a)(iv). In any case, all of the answers are correct. Full marks.

(ii) Measure the angle of incidence and the angle of refraction for the light entering the prism.

(2)

angle of incidence = 45 degrees

angle of refraction = 42 degrees

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

(1)

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

(iv) Calculate the refractive index of the glass.

(2)

$\frac{\sin(45)}{\sin(42)} = 1.06$

refractive index = 1.06

ResultsPlus
Examiner Comments

Even though this candidate has mis-measured the angle of refraction – which was not unusual – they have completed the rest of the question perfectly. This scores all the marks bar 1 mark in Q07(a)(ii) under error carried forward rules. 4 marks in total.

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

Most candidates found the change in wavelength successfully and made some headway with the calculation in Q07(b)(ii). A small minority of candidates made minor slips along the way, again through inaccurate substituting or rearrangement. Substituting the galaxy wavelength instead of the lab wavelength in the denominator of the formula was a reasonable misconception.

(b) Two galaxies, A and B, emit red light with a reference wavelength of 630 nm.

An astronomer measures the wavelength of red light from galaxy A when the light arrives at the Earth.

The astronomer's value for the wavelength is 645 nm.

(i) Calculate the difference between the astronomer's value for the wavelength and the reference wavelength of red light.

(1)

645 - 630 = 15

difference in wavelength = 15 nm

(ii) The change in wavelength happens because galaxy A is moving away from the Earth.

Calculate the speed of galaxy A.

[speed of light = 3.0×10^8 m/s]

(3)

$\frac{\text{change in wavelength}}{\text{reference wavelength}} = \frac{\text{velocity of galaxy}}{\text{speed of light}}$

$\frac{15}{645} = \frac{x}{3.0 \times 10^8}$

speed = 6976744.2 m/s

$\frac{15}{645} \times 3.0 \times 10^8 = 6976744.186$

ResultsPlus
Examiner Comments

This candidate has used the observed wavelength instead of 630 nm in the denominator of the formula. We thought this was an error of physics with a maximum mark of 1 for this part, given that everything else is acceptable. 2 marks in total for these parts.

ResultsPlus
Examiner Tip

Check which variable goes where.

(b) Two galaxies, A and B, emit red light with a reference wavelength of 630 nm.

An astronomer measures the wavelength of red light from galaxy A when the light arrives at the Earth.

The astronomer's value for the wavelength is 645 nm.

(i) Calculate the difference between the astronomer's value for the wavelength and the reference wavelength of red light.

(1)

645 - 630

difference in wavelength = 15 nm

(ii) The change in wavelength happens because galaxy A is moving away from the Earth.

nanometers → m?

Calculate the speed of galaxy A.

[speed of light = 3.0×10^8 m/s]

$\frac{\text{change in wavelength}}{\text{reference wavelength}} = \frac{\text{velocity of galaxy}}{\text{speed of light}}$

(3)

$\frac{15\text{nm}}{630\text{nm}} = \frac{\text{velocity}}{3 \times 10^8}$

$(3 \times 10^8 \times 15) = 630\text{v}$

7142857.143

speed = 7142857.143 m/s

$v = \frac{(3 \times 10^8 \times 15)}{630} = 7142857.143\text{ nm/s}$

ResultsPlus
Examiner Comments

In comparison, this candidate has used the correct wavelengths everywhere arriving at the correct answer. Full marks awarded.

Question 7 (b)(iii)

This item was one of the most challenging on the paper. Most candidates did not score anything at all. This is because most candidates repeated things they knew about the Big Bang theory, rather than linking the experimental evidence in the question to the evidence supporting cosmological redshift. Those candidates that were successful first of all made the link between redshift and speed of recession. Many candidates did not and effectively repeated the question, which is never creditworthy.

The second challenging idea is that there was a link between distance and speed (not distance and redshift as that's in the question). Equally acceptable was linking either of these ideas to the fact that galaxies are moving apart or moving away from each other. Simply moving away from Earth is insufficient.

(iii) Light from galaxy B has twice the redshift as light from galaxy A.

Galaxy B is twice as far away from Earth as galaxy A.

Explain how these observations support the Big Bang theory of the origin of the Universe.

(2)

The big bang theory suggests an explosion occured which sent things like galaxies and stars from the origin point. The star that twice the redshift occurs when the galaxy is twice the distance suggests evidently that it is still moving and supports the big bang theory

ResultsPlus
Examiner Comments

This candidate has not said anything incorrect, however they have not added to or linked the data in the question to anything else and so scored zero.

ResultsPlus
Examiner Tip

Re-read your answers if you have time. Check to see if you've just repeated the question.

Question 8 (a)

Most experimental or investigative questions have a large number of marking points to give candidates a chance to say enough to score highly. This item was no exception, with ten marking points available covering many different approaches.

This experiment is listed as a required practical (specification item 5.14P) so candidates should be fully aware of how to describe it accurately, including how to perform the required analysis and any precautions needed to acquire quality data.

The "Guide for core practicals" as mentioned in the introduction is very useful in this regard.

Describe a suitable method to find the specific heat capacity of concrete.

S.H.C. (5)

Specific Heat Capacity is the amount of energy required to increase 1 kg of a substance by 1 °C. To find the S.H.C of concrete, you can apply charge to the circuit, allowing the electrical heater to heat up, recording the time taken using a stopwatch for the concrete block to heat up by 1 °C. Repeat this twice more, using timed results to calculate an average and rearrange the equation: $\Delta Q = m \times c \times \Delta T$ to find specific heat capacity of water. The insulating material ensures more reliable results, reducing energy lost dissipating as heat to surroundings and thermometer to check temperature.

ResultsPlus
Examiner Comments

The candidate mentions the definition for specific heat capacity (SHC) at least twice, in the first sentence and the last. They score their three marks with the second and third sentences. They make it clear what they are going to do for their method, namely use a stopwatch to measure the time for a temperature rise of 1 degree (marking points 2 and 3). The experiment is repeated and averaged also (marking point 10). There is no mention of a kg or a specific measuring of the mass of the block. Nor is there mention of how to measure the energy supplied to the block. 3 marks awarded.

Describe a suitable method to find the specific heat capacity of concrete.

(5)

The scientist should first measure the mass of only the concrete. Next, she should increase the heat released by the electrical heater and start a stopwatch. The beginning temperature needs to be recorded with the thermometer, looking directly at it to avoid parallax error. Then, as well as voltage and current once a desired temperature is reached (e.g 40°C), the measurements on the voltmeter and ammeter are recorded, as well as the final temperature and total time passed. Assuming all of the energy is electrical and E=VIt the total energy can be found (which equals ΔQ). Then, using the equation $c = \frac{Q}{m\Delta T}$, the specific heat capacity of concrete can be measured. The experiment should be repeated and the average value for each ~~result~~ measurement should be calculated before using the

ResultsPlus
Examiner Comments

This candidate has provided a full explanation of their method, including how they will measure the mass, energy and temperature rise. They are explicit about making the SHC the subject of the relevant equation (merely quoting the equation is insufficient) as well as repeating the experiment to find an average. An excellent response which merited full marks.

Question 8 (b)

The most challenging item on the paper. Most candidates scored zero. This is because the ideas here are complex – the concrete is intended to store a large amount of energy and then release it over a long period of time to the water.

(b) Explain the advantage of the concrete having a high specific heat capacity when it is used to heat water in the heating system. time taken to ↑ 1kg by 1°C.

(2)

high specific heat capacity means it takes a long time for 1kg to be increased in temprature by 1°C. This is advantageous because it means that the concrete stores more energy so that the water can heat up more efficiently. It's also advantageous because it means energy will not be lost from the concrete for a long time so heating of the water is sustained.

ResultsPlus
Examiner Comments

An excellent answer that shows that the candidate has applied their knowledge to the context flawlessly. 2 marks awarded.

(b) Explain the advantage of the concrete having a high specific heat capacity when it is used to heat water in the heating system.

(2)

It stores a lot of energy when heated and therefore is able to heat more water for a longer period of time.

ResultsPlus
Examiner Comments

While this candidate has used fewer words and simpler language than in the previous answer, their response is just as valid. 2 marks awarded.

ResultsPlus
Examiner Tip

A small number of the items on this paper are specifically designed to be very challenging, enabling candidates to explore and demonstrate their ability to the fullest. Having a think and writing something sensible is a good strategy here.

Paper Summary

Based on their performance on this paper, candidates should:

- Ensure that they have either seen or performed the practicals named in the specification, where possible. This includes being ready to comment on data, evaluating a method and linking data to ideas and evidence.
- Take note of the command word used in each question to determine how the examiner expects the question to be answered, for instance whether to give a description or an explanation.
- 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.
- 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.
- Signpost working with words, it may help with structuring calculations clearly.
- Take care to follow the instructions in the question, for instance when requested to use particular ideas in the answer.
- Take advantage of opportunities to draw labelled diagrams as well as, or instead of, written answers.
- 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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