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Examiners' Report
June 2025

Int GCSE Physics 4PH1 2P

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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 the less able candidates tended to struggle when assembling a logical description or when asked to offer more than one idea. There were a wide range of responses and it was good to see that many candidates could give full and accurate answers.

Question 1(a)

A relatively straightforward first item. Many candidates appreciated the need to call the apparatus by the correct name, as in all previous series. A large proportion made reference to "repeating and averaging" however that does not answer the question here - this is about how to use a balance.

1 A student plays a game using a single dice.

The student decides to determine the density of the dice by measuring its mass and volume.

(a) Describe how the student could accurately measure the mass of the dice.

(2)

Use a top-pan balance ~~to find the mass~~, making sure ~~the~~ it is zeroed first.

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Examiner Comments

Perfectly and concisely expressed.

1 A student plays a game using a single dice.

The student decides to determine the density of the dice by measuring its mass and volume.

(a) Describe how the student could accurately measure the mass of the dice.

(2)

Use an electronic balance to measure mass of 5 dice and take an average.

ResultsPlus Examiner Comments

The candidate has mentioned using the correct apparatus (not a scale) yet has mentioned taking an average, rather than mentioning about the procedure of making a single mass reading. This response scored one mark.

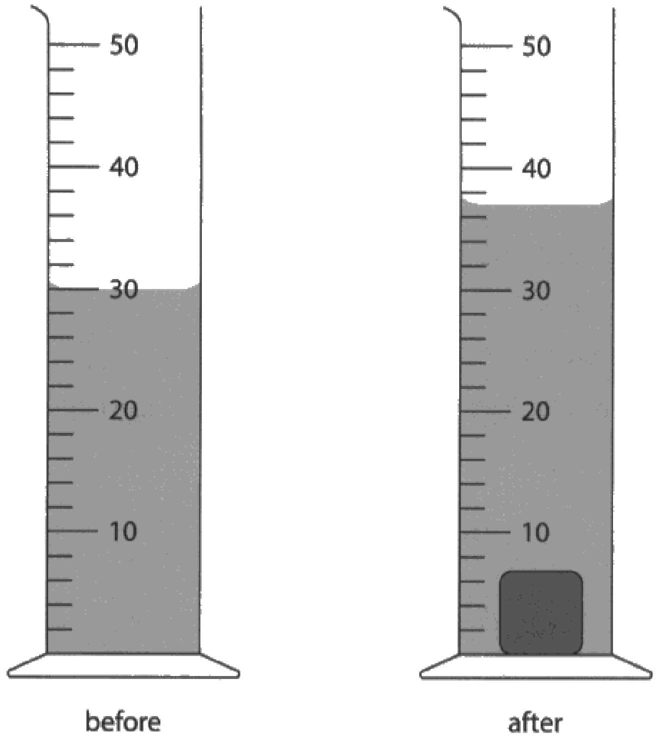
Question 1(b)

Q01(b)(i): almost all candidates read at least one of the measuring cylinder values correctly, with the majority then going on to calculate the volume of the dice appropriately.

Q01(b)(ii): as the formula was included in the question, almost all candidates substituted in the mass and their volume from part Q01(b)(i) in the correct places. They then followed this up by correctly evaluating the density. Successful candidates also left the mass and volume in the original units and hence assigned the right unit to the answer line. Less successful candidates attempted at least one conversion and almost invariably made a mistake.

NB - the singular word 'dice' was chosen for clarity.

The diagram shows the water in the measuring cylinder before and after the dice is fully submerged.



(i) The measuring cylinder gives volume in units of cm^3.

Using the diagram, determine the volume of the dice.

(2)

$47 - 30 = 17$

volume = 17 cm^3

(ii) The dice has a mass of 9.2 g.

Calculate the density of the dice using the formula

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

Give a suitable unit.

$9.2 \div 1000 = 9.2 \times 10^{-3}$

(3)

$17 \div 1000 = 0.017 m^3$

~~9.2~~

$\frac{9.2 \times 10^{-3}}{0.017} = 0.54 (2sf)$

density = 0.54 unit Kg/m^3

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Examiner Comments

This response scores one mark for part Q01(b)(i), as the reading of 30 cm^3 is clear.

In part Q01(b)(ii), the candidate has performed two unit conversions, both of which were unnecessary. The conversion to kg from g is correct but the conversion to m^3 is not. This meant that their evaluation of the number does not correctly match the unit, hence two marks awarded.

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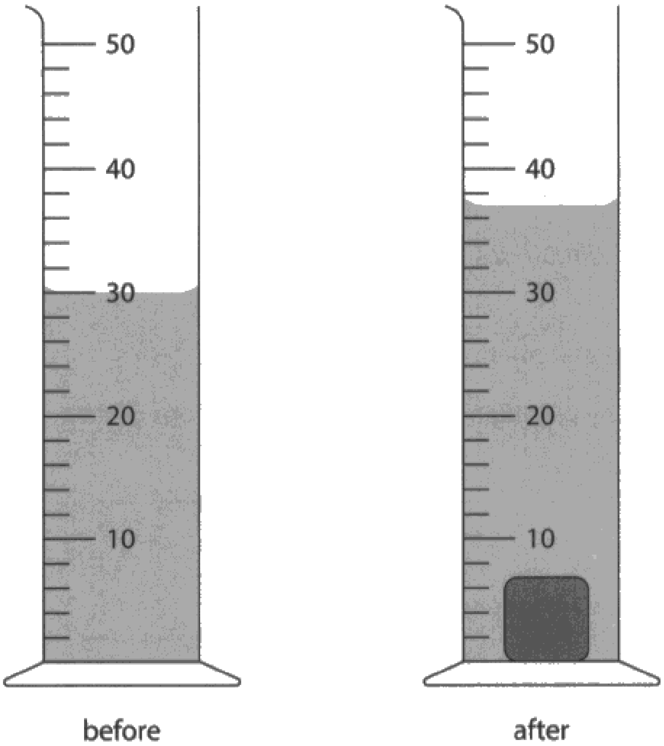
Examiner Tip

Unless you are expressly asked to do so, it is wise to leave measurements in their original units. Also, even though the density of water is not on the specification as a piece of data, it is useful to remember that it is 1000 kg/m^3 or 1 g/cm^3.

The diagram shows the water in the measuring cylinder before and after the dice is fully submerged.



(i) The measuring cylinder gives volume in units of cm^3.

Using the diagram, determine the volume of the dice.

$37 - 30 = 7$

(2)

volume = 7.0 cm^3

(ii) The dice has a mass of 9.2 g.

Calculate the density of the dice using the formula

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

Give a suitable unit.

$d = \frac{9.2g}{7cm^3} = 1.3$ (2SF)

(3)

density = 1.3 unit g/cm^3

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Examiner Comments

This candidate has performed all of the steps carefully and correctly.

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Examiner Tip

Putting the units as well as the numbers into a formula can help determine the correct unit of the calculated value. This candidate has done that, ie 9.2 g divided by 7 cm^3, to give the unit of density as g/cm^3.

Question 2(b)

Q02(b) proved straightforward for the majority of candidates. A small number of candidates selected more than two options, limiting them to a maximum of one mark.

(b) The table gives some statements about sound waves.

Complete the table by placing a tick (✓) next to each correct statement.

(2)

Statement	Correct (✓)
sound waves are longitudinal	✓
sound waves can travel through a vacuum	✓
sound waves are part of the electromagnetic spectrum	
sound waves can be reflected and refracted	✓

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Examiner Comments

Two correct options plus one incorrect option means a score of one mark only.

(b) The table gives some statements about sound waves.

Complete the table by placing a tick (✓) next to each correct statement.

(2)

Statement	Correct (✓)
sound waves are longitudinal	✓
sound waves can travel through a vacuum	
sound waves are part of the electromagnetic spectrum	
sound waves can be reflected and refracted	✓

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Examiner Comments

The correct answer.

Question 2(c)(i)

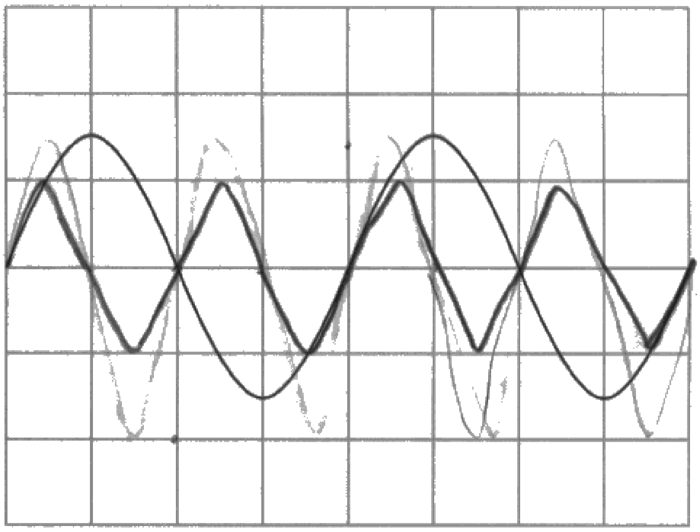
The only acceptable answer for Q02(c)(i) was 'time' or its abbreviation 't'. 'Time period' or 'time base' are not the correct variable here. 'T' is the letter given to the period of a wave or vibrating motion and so was also unacceptable.

Question 2(c)(ii)

Q02(c)(ii) was comparatively straightforward compared to similar questions in the past, as the only two requirements were that the wave form had a lower amplitude and a longer period.

Almost all candidates could draw the waveform with a lower amplitude. Some candidates drew a waveform with the same period or with a shorter period and so could not score the second mark.

(ii) The diagram shows the trace on an oscilloscope screen when a sound wave is detected.



On the screen, draw the trace for a quieter sound wave with a lower frequency.

(2)

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Examiner Comments

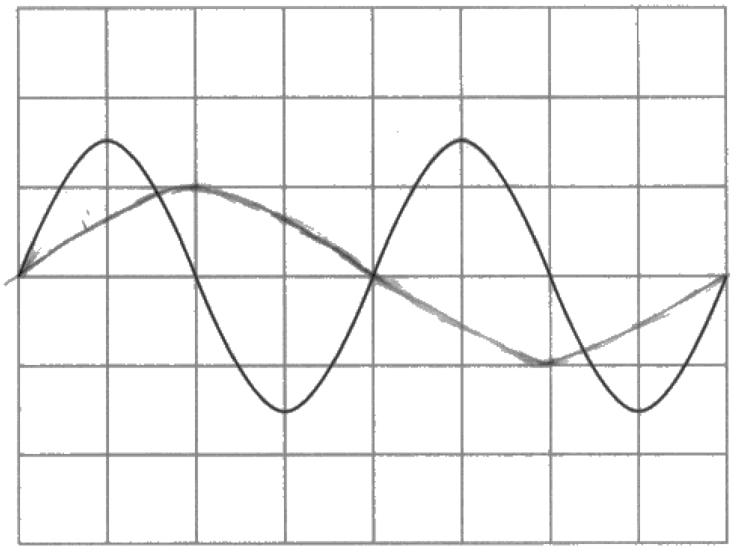
Notice that the candidate has appeared to draw a second curve. This has happened because rubbed out work can still be picked up by the scanning process. Avoid using erasable pen if you can.

The candidate's intention is clear. The amplitude of their response is less than that of the original waveform.

The period is shorter than the original so cannot be correct.

This response scored one mark.

(ii) The diagram shows the trace on an oscilloscope screen when a sound wave is detected.



On the screen, draw the trace for a quieter sound wave with a lower frequency.

(2)

ResultsPlus Examiner Comments

Here both the amplitude of the wave is correct (ie lower than the original) and the period is clearly much longer than that of the original. This means that the frequency is higher than the original and so is correct.

Question 3(a)

Long answer items on the energy topic are challenging. The language used to describe energy stores and energy transfers is concise in the specification - there are eight energy stores and only four energy transfers.

This is slightly different to the description more prevalent in centres. The mark scheme has to reflect acceptable answers using either scheme. This is shown in the three marking points in the 'notes' column of the mark scheme as an alternative description. It was not possible to take marking points from both schemes.

Centres might consider using the 'newer' version of thinking about energy as it deals with specific points in a given context and is more representative of processes that are actually taking place.

Overall there was some confusion about which energy store was being depleted in the Sun, or in the alternate description, the role played by the panel itself. Candidates broadly understood that the end result was a chemical store in the battery.

3 The photograph shows a camper van with a solar panel on its roof. The solar panel is made from lots of solar cells connected together.

(Source: © kostasgr / Shutterstock)

The solar panel is connected to a battery. The solar panel receives energy from the Sun to charge the battery.

RHEM

(a) Describe how energy is transferred from the Sun's energy store to the battery's energy store.

(3)

• energy is transferred by radiation from the sun's ~~thermal~~ nuclear ~~chemical~~ energy store to the ~~sun~~ battery's chemical energy store

• ~~it~~ radiation can travel in a vacuum as it doesn't require a medium to travel through

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Examiner Comments

This candidate scored marking points 1, 2 and 5 in the first sentence. The second sentence is superfluous.

3 The photograph shows a camper van with a solar panel on its roof. The solar panel is made from lots of solar cells connected together.

(Source: © kostasgr / Shutterstock)

The solar panel is connected to a battery. The solar panel receives energy from the Sun to charge the battery.

(a) Describe how energy is transferred from the Sun's energy store to the battery's energy store.

(3)

The Sun's energy is transferred by radiation and when it hits the solar cells ~~it~~ the energy is transferred to the battery's chemical energy store ~~the~~ electrically

ResultsPlus Examiner Comments

This candidate scored three marks in a different way, by firstly saying that the energy is transferred by radiation (marking point 2). After this, they focused on the battery. They referred to the chemical store of the battery (marking point 5) which happens electrically (marking point 4).

3 The photograph shows a camper van with a solar panel on its roof. The solar panel is made from lots of solar cells connected together.

(Source: © kostasgr / Shutterstock)

The solar panel is connected to a battery. The solar panel receives energy from the Sun to charge the battery.

(a) Describe how energy is transferred from the Sun's energy store to the battery's energy store.

(3)

energy transfer by thermal store of the sun by thermal transfer to chemical store in battery.

ResultsPlus
Examiner Comments

The picture is more confused here, although the candidate has gained one mark by referring to the chemical store of the battery.

Question 3(b)

There were four ideas that candidates could use that were creditworthy. As in previous series, 'greenhouse gas' has been deemed insufficient.

Question 3(c)

While a small number of candidates suggested that conduction or emission was the thermal transfer mechanism at play here, most referred correctly to black being a good absorber.

The most likely way for a candidate to drop the second mark was to be unclear about what was being absorbed.

(c) The surface of the solar panel is black.

Explain why black is a suitable colour for the solar panel.

(2)

Black is a good colour for insulating light rays from ~~s~~ the Sun. Therfore, they won't be reflected back. like the color white.

ResultsPlus
Examiner Comments

There is no mention of black being a good absorber. Although there is mention of light rays, the context is completely incorrect (ie insulation) so no marks.

(c) The surface of the solar panel is black.

Explain why black is a suitable colour for the solar panel.

(2)

The colour black is a good absorber, so it will absorb all of the Sun's radiation. This maximises the amount that the battery is charged. By absorbing a lot ~~lots~~ of radiation, a lot ~~lots~~ of energy is transfered.

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Examiner Comments

This candidate has scored both marks on the first line.

Question 3(d)

A straightforward calculation using a formula from the insert. The most likely slip that candidates made was to incorrectly rearrange the formula although some incorrectly substituted.

(d) The solar panel can charge the battery in the camper van with a maximum current of 15 A.

Calculate the minimum time to transfer 360 000 C of charge through the battery.

Use the formula

charge transferred = current × time

(3)

$Q = It$

$t = Q \div I$

$t = 3.6 \times 10^5 \div 15$

$t = 2.40 \times 10^4$ s

minimum time = 2.40×10^4 s

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Examiner Comments

A very clear response, completed in standard form, that scored three marks.

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Examiner Tip

Use of standard form can help candidates avoid Powers of Ten (PoT) errors - it removes the need to add multiple zeros.

(d) The solar panel can charge the battery in the camper van with a maximum current of 15 A.

Calculate the minimum time to transfer 360 000 C of charge through the battery.

Use the formula

charge transferred = current × time

(3)

$Q = I \times t$

$t = \frac{Q}{I}$

$t = \frac{360\,000}{15} = 24\,000\text{ s}$

minimum time = 24 000 s

ResultsPlus
Examiner Comments

Another clear example: not using standard form is absolutely fine as well.

(d) The solar panel can charge the battery in the camper van with a maximum current of 15 A.

Calculate the minimum time to transfer 360 000 C of charge through the battery.

Use the formula

charge transferred = current × time

(3)

$\text{time} = \frac{\text{charge}}{\text{current}}$ $\cancel{\frac{15}{360000}} = \cancel{4.0}$

$\frac{15}{360000} = 4.167$

minimum time = 4.167 s

ResultsPlus
Examiner Comments

By rearranging the equation correctly, this candidate has scored a mark. The substitution and therefore the subsequent evaluation is incorrect though.

(d) The solar panel can charge the battery in the camper van with a maximum current of 15 A.

Calculate the minimum time to transfer 360 000 C of charge through the battery.

Use the formula

charge transferred = current × time

(3)

$360000 = 15 \times x$

$360000 \times 15 = x$

$5400000 = x$

minimum time = 5400000 s

ResultsPlus
Examiner Comments

Here the substitution is correct however the rearrangement and subsequent evaluation has gone wrong. This answer scored one mark.

Question 4(a)

Q04(a)(i): this item is a 'show that' question, which requires the candidate to show their working and how they arrive at a number that is consistent with the number quoted in the question yet is to at least one more significant figure than that number. Most candidates used the correct formula, substituted correctly and then showed their final number in full. A small percentage of candidates did not show their value.

Q04(a)(ii): although most candidates correctly quoted the Principle of Moments, others confused this with the conservation of momentum or conservation of energy.

Q04(a)(iii): if a candidate got parts Q04(a)(i) and Q04(a)(ii) correct then they almost always got full marks for this part. Those that did not usually mis-substituted or mis-rearranged the equation.

(a) When the handle is pulled to the right, the spring applies a force on the handle to the left.

The vertical distance between the spring and the pivot point of the handle is 22 cm.

The force from the spring is 5.2 N.

(i) Show that the force from the spring produces a moment of approximately 1 Nm.

22 ÷ 100 = 0.22

(3)

Moment = Force × Perpendicular distance from pivot

5.2 × 0.22 = 1.144 Nm

is approximately 1 Nm

(ii) State what is meant by the term **principle of moments**.

(1)

~~An~~ Total anticlockwise moment = Total clockwise moment

(iii) Force F acts on the handle to keep the handle stationary so that the gate can be opened.

Force F acts at a vertical distance of 70 cm from the pivot point of the handle.

Calculate the magnitude of force F. 70 ÷ 100 = 0.7m

(3)

5.2 × 0.22 = 0.7 × ?

1.144 ÷ 0.7 = 1.63 (2dp)

magnitude of force F = 1.63 N

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Examiner Comments

This candidate has laid everything out clearly.

Q04(a)(i) - They have been clear about the conversion from cm to m, then substituted and evaluated the moment correctly to more than the number of significant figures of the approximate value.

Q04(a)(ii) - The statement of the principle of moments is correct, including the idea of total moment in either direction.

Q04(a)(iii) - Using the calculated value for part Q04(a)(i), the magnitude of force F has been calculated correctly.

This response scored seven marks in total.

(a) When the handle is pulled to the right, the spring applies a force on the handle to the left.

The vertical distance between the spring and the pivot point of the handle is 22 cm.

The force from the spring is 5.2 N.

(i) Show that the force from the spring produces a moment of approximately 1 Nm.

(3)

5.2×22

$= 114.4$ N

≈ 1 Nm

(ii) State what is meant by the term **principle of moments**.

(1)

Moment beforn turning equals to moment after turning.

(iii) Force F acts on the handle to keep the handle stationary so that the gate can be opened.

Force F acts at a vertical distance of 70 cm from the pivot point of the handle.

Calculate the magnitude of force F.

(3)

$1 \text{ Nm} = F \times 70$

$F = 1.634$ N

magnitude of force F = 1.63 N

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Examiner Comments

Q04(a)(i) - This candidate has not converted the distance into metres from centimetres. This would have been acceptable, had they quoted the unit for the moment as N cm.

Q04(a)(ii) - The statement is incorrect.

Q04(a)(iii) - The distance is in centimetres here as well, although the candidate has apparently taken this into account with their answer on the line being correct.

This response scored five marks in total.

Question 4(b)

There were plenty of ways of making the gate easier to operate. Most candidates suggested extending the length of the handle or moving the spring closer to the pivot point.

A considerable fraction of candidates suggested the idea of making the spring exert less force, although attempts to do that were variably successful.

(b) Give two changes to this gate mechanism that would make it easier to open the gate.

(2)

1 Make the handle longer

2 Decrease the tension (force) of the spring by changing it for a weaker one.

(Total for Question 4 = 9 marks)

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Examiner Comments

Both of these ideas are creditworthy. The candidate has been slightly unsure how to articulate their idea of the force applied by the spring however the meaning is clear.

(b) Give two changes to this gate mechanism that would make it easier to open the gate.

(2)

1 Longer handle, so less force needs to be applied

2 ~~bigger~~ loosen the spring so ~~it~~ it is less tight, so less force needs to be applied.

(Total for Question 4 = 9 marks)

ResultsPlus
Examiner Comments

This response shows the same ideas from the previous example yet in a different way. Both ideas acceptable.

(b) Give two changes to this gate mechanism that would make it easier to open the gate.

(2)

1 Greater distance between pivot point and ~~handle~~ Force F of the handle

2 Smaller distance between spring and pivot point

(Total for Question 4 = 9 marks)

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Examiner Comments

The first idea again clearly acceptable.

The second idea is also correct. A shorter distance between the spring and the pivot will decrease the moment of the spring force. This requires a lower applied force at the handle to achieve the same moment as that of the spring force.

Question 5(a)

Any named conductor was sufficient for this item. Virtually all candidates either stated 'metal' or named a specific conductor.

Question 5(b)

A large proportion of candidates successfully identified the transfer of negative charges as the reason why the ball became positively charged. Most of those also mentioned that those negative charges were in fact electrons.

As ever, reference to the movement of positive charges negates anything else in the response, scoring zero.

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

(2)

The ball has been positively charged as it has lost its electrons. these electrons are negatively charged. & if the ball loses electrons it can only has a positive charge left.

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Examiner Comments

Even though the candidate has effectively repeated themselves, they have got the right concept here. This response scored two marks.

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

(2)

The negatively charged ions have been removed from the ball, so only the positively charged ions remain

ResultsPlus
Examiner Comments

The idea of a transfer of negative charge is certainly here, except the candidate has referred to ions instead of electrons. This means that the second mark cannot be awarded.

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

(2)

Positively charged particles flow to the end ~~of~~ the string and flow into the ball making it positively charged.

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Examiner Comments

The idea of the movement of positive charge to make the ball positively charged is wrong and so as dictated by the mark scheme, no marks at all can be awarded, regardless of any other creditworthy content.

Question 5(c)(i)

There are two concepts here. The first is that the ball moves towards the rod. This implies that the rod must be negatively charged **because** opposite charges attract. Successful candidates often ran these two ideas together by stating 'opposite charges attract'. A small number of candidates mis-named charges by calling them 'poles' or some did not mention the idea of 'oppositeness'.

'Unlike' charges was not sufficient as it does not necessarily convey the idea of a difference of sign of charge.

The student brings a negatively charged polythene rod near to the right side of the ball.

The ball moves, as shown in diagram 3.

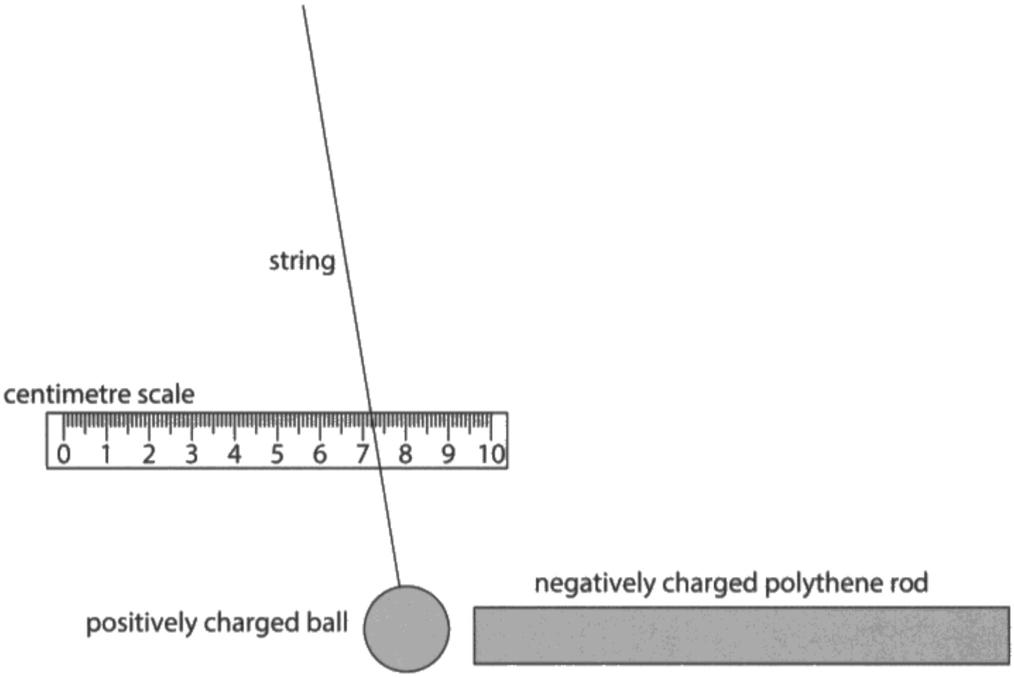

Diagram 3

(i) Explain how the movement of the ball shows that the charge on the polythene rod is negative.

(2)

Since the ball moves towards the polythene rod, the rod must be negative as a positively charged ball has attracted to it.

ResultsPlus Examiner Comments

The response certainly includes the idea of the rod and ball attracting, however there is no statement of the 'oppositeness' of the two charges. One mark was awarded.

The student brings a negatively charged polythene rod near to the right side of the ball.

The ball moves, as shown in diagram 3.

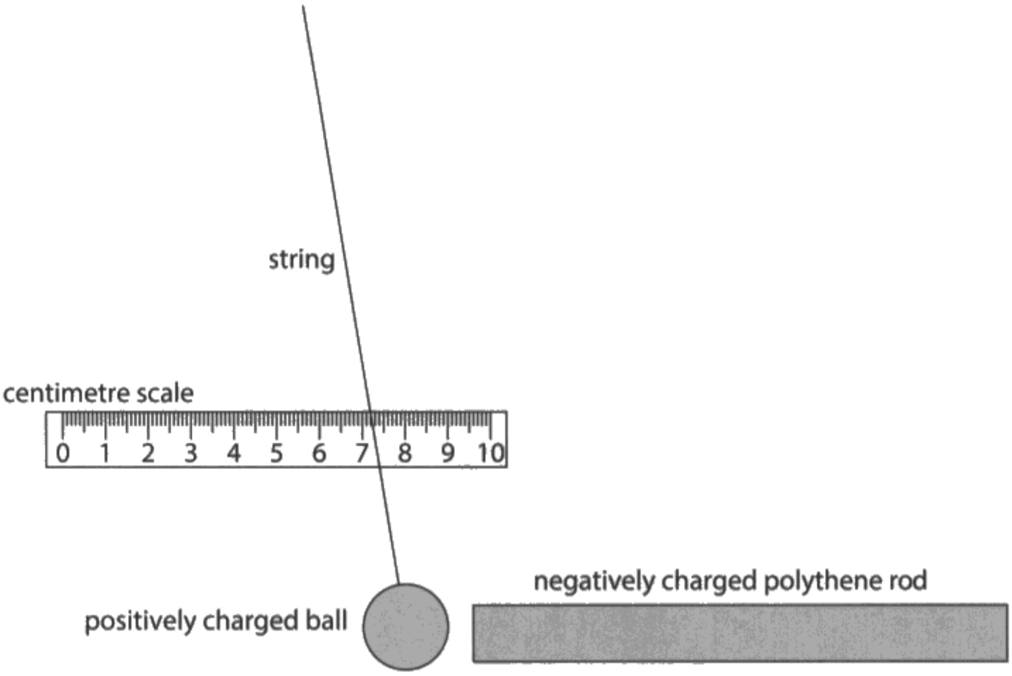

Diagram 3

(i) Explain how the movement of the ball shows that the charge on the polythene rod is negative.

(2)

• Because the ball moves over 2cm towards the rod and opposite charges attract. Since the ball is positively charged, the rod must be negatively charged as the ~~ball~~ rod attracts the ball

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Examiner Comments

This response includes the short yet doubly creditworthy 'opposite charges attract' in line two. There is no contradictory material so both marks were awarded.

Question 5(c)(ii)

Any value greater than 5.0 cm or less than 7.2 cm was acceptable.

Values over 7.2 cm were not acceptable as **in equilibrium**, the force between the rod and the ball will be smaller, causing a smaller deflection.

Question 5(d)

There were three acceptable trains of thought for this item. Most successful candidates suggested that the dimensions of the rod needed to be the same, although has a very large number of ways of expressing that. Slightly fewer suggested either of the other two. Again there were lots of ways of expressing 'the same distance between rod and ball' and 'keep the charge on the ball the same'. Trivial ideas such as 'same ruler', 'same string' and so on were not acceptable.

(d) The student extends the investigation by measuring the reading on the scale for rods made from different materials.

As a control variable, the student charges each rod by rubbing it with a cloth the same number of times.

Give two other control variables for the student's investigation.

(2)

1 Distance rod is held from the ball.

2 The cm value the string lines up with.

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Examiner Comments

The first idea is certainly creditworthy. The second idea is not - the initial position of the ball makes no difference.

(d) The student extends the investigation by measuring the reading on the scale for rods made from different materials.

As a control variable, the student charges each rod by rubbing it with a cloth the same number of times.

Give two other control variables for the student's investigation.

(2)

1 she should apply the same amount of force when rubbing the rods, to ensure the same amount of friction.

2 she should use the same ball each time

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Examiner Comments

This candidate successfully described how to achieve the same charge on the ball each time, scoring the second marking point on the mark scheme. Changing the ball would fundamentally change the experiment and so was deemed not acceptable.

(d) The student extends the investigation by measuring the reading on the scale for rods made from different materials.

As a control variable, the student charges each rod by rubbing it with a cloth the same number of times.

Give two other control variables for the student's investigation.

(2)

1 use the same cloth material to rub each rod

2 the distance the rod is placed away from the ball

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The candidate's second idea here is creditworthy, scoring the first marking point on the mark scheme. Keeping the same cloth was also deemed integral to the experiment and so was not applicable.

Question 5(e)(i)

A large proportion of candidates successfully described the material as a categoric variable, or one of the acceptable alternatives given in the mark scheme.

Some candidates hold the misconception that the only difference between a bar chart and a scatter or line graph is the 'ease of representation of data' and that the two are totally interchangeable.

Question 5(e)(ii)

The data in the question allowed candidates to express all sorts of interesting comparisons, many of which were very successful. They had clearly followed the rest of the question so that they understood what a push to the left or a pull to the right on the ball would signify in terms of the charge on the rod.

There were a small number of candidates that got the analysis backwards, ie swapping positive for negative.

(ii) Deduce what can be concluded about the charge on each of the rods used in the investigation.

Use information from the bar chart to help your answer.

(3)

Ebonite and polyethene are both negatively charged. Wood has no charge. Glass and nylon are positively charged.
Ebonite is the most negatively charged because it attracts the ball the furthest distance.
Glass is the most positively charged because it repels the ball the furthest distance.

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Examiner Comments

An excellent response that scored three marks in the first sentence. The other two sentences would have scored marking point seven and marking point six respectively.

(ii) Deduce what can be concluded about the charge on each of the rods used in the investigation.

Use information from the bar chart to help your answer.

(3)

Glass would have a negative charge Because it doesnt move as much meaning the rod and glass arent oppostly charged ions same with wood and Nylon, however Ebonite + Polythene both had a larger reading on scale showing they were positivly charged as opposites attract making the ball move.

ResultsPlus
Examiner Comments

Unfortunately this candidate has misunderstood the experiment, ignoring the direction of the ball's deflection relative to the 5cm mark. This response scored zero marks.

Question 6(b)(i)

Most candidates suggested one of the three correct alternatives on the mark scheme. A small number suggested a vague reference to simply 'improving accuracy or reliability' which was not creditworthy.

Question 6(b)(ii)

Many candidates were familiar with this type of question. Most candidates selected two points on the graph, calculated the 'constant' for both points and then drew a valid conclusion from the similarity of those two constants.

Responses that included no reference to the data or no calculations of a constant scored zero.

The student claims that the data obeys the formula

count × distance² = constant

Evaluate the student's claim. **(3)**

$0.075^2 \times 8400 = 47.25$

$0.11^2 \times 4000 = 48.4$

$0.225^2 \times 1000 = 50.625$

$0.15^2 \times 2200 = 49.5$

The student is incorrect, the values ~~increase~~ vary and are not exactly the same ~~as the distance increases~~, there is no constant & it does not obey the formula as he said, the values are not exactly the same ~~only~~ only approximately the same.

(Total for Question 6 = 5 marks)

ResultsPlus
Examiner Comments

This candidate has done exactly as intended. They have calculated the constant for at least two points on the curve. Incidentally they have converted the distance into metres, possibly by habit. This has meant that their constants are more manageable numbers. This was not necessary and might have been risky.

Finally, they have provided a reason for their conclusion that the student is incorrect.

This response scored three marks.

The student claims that the data obeys the formula

$$\text{count} \times \text{distance}^2 = \text{constant}$$

Evaluate the student's claim.

(3)

The student claims that the count exponentially decreases which would mean that the ~~formula~~ data obeys the formula as if you square it it would be a straight line not a curve

(Total for Question 6 = 5 marks)

ResultsPlus
Examiner Comments

This response has no reference to the data at all, so cannot score any marks, regardless of the candidate's conclusion.

ResultsPlus
Examiner Tip

Use words such as 'exponential' with extreme caution. In this context it is incorrect (the only obvious exponential is an activity-time graph in the radioactivity topic and even then, that language is not on the specification). This candidate has tried to use mathematical language without actually answering the question.

Question 7(a)

Q07(a)(i): nearly all candidates selected the correct formula from the formula booklet.

Q07(a)(ii): a very small number of candidates used a different formula for this item, ie they assume that the transformer was 100% efficient and used the power formula. A large proportion though used the formula required for part Q07(a)(i) and either substituted correctly or rearranged the formula correctly. The majority of candidates, therefore, scored all three marks. Successful candidates often look through the whole question before deciding how to approach each item.

Q07(a)(iii): the final item in this part consisted of multiple steps. Firstly, the data from the table should be used to find the input or primary power. Then, with the output current and the output voltage, the candidate should find the output power. This alone was sufficient for three marks if done correctly.

Finally, using the given equation and assuming that they had values for the input and output power, most candidates went on to find an appropriate efficiency expressed as a percentage. Some forgot to do the multiplication by 100 state.

(i) State the formula linking input (primary) voltage, output (secondary) voltage and the turns ratio for a transformer.

(1)

$$\frac{\text{input voltage}}{\text{output voltage}} = \frac{\text{primary turns}}{\text{secondary turns.}}$$

(ii) Use data from the table to calculate the output (secondary) voltage of the transformer.

(3)

$$\frac{230}{V_2} = \frac{1000}{300}$$

$$\frac{230}{V_2} = 3.3$$

$$V_2 = 69$$

output (secondary) voltage = 69 V

(iii) This transformer is not 100% efficient.

The efficiency of a transformer can be calculated using the formula

$$\text{efficiency} = \frac{\text{useful output power}}{\text{total input power}} \times 100\%$$

Calculate the efficiency of the transformer.

(5)

Input power = $230 \times 1.3 = 299$

output power = $69 \times 4.0 = 276$

$$\frac{276}{299} \times 100 = 92.307$$

efficiency = 92.3 %

ResultsPlus
Examiner Comments

A clear and fully correct response.

(i) State the formula linking input (primary) voltage, output (secondary) voltage and the turns ratio for a transformer.

(1)

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

(ii) Use data from the table to calculate the output (secondary) voltage of the transformer.

(3)

$$\frac{\text{input (primary) voltage}}{\text{input (primary) current}}$$

$$\frac{230}{1.3} = 176.92$$

output (secondary) voltage = 177 V

(iii) This transformer is not 100% efficient.

The efficiency of a transformer can be calculated using the formula

$$\text{efficiency} = \frac{\text{useful output power}}{\text{total input power}} \times 100\%$$

Calculate the efficiency of the transformer.

(5)

useful output power = 177 + 4.0 = 181

total input power = 230 + 1.3 = 231.3

$$\frac{181}{231.3} = 0.782$$

$$0.782 \times 100 = 78.2$$

efficiency = 78 %

ResultsPlus
Examiner Comments

Q07(a)(i) - The formula is totally correct.

Q07(a)(ii) - This candidate has chosen to ignore the formula they have just written and use a different erroneous approach. Zero marks.

Q07(a)(iii) - The working here is not consistent with use of power = current × voltage so none of the first three marks are achievable. The candidate has gone on to use the given formula correctly, using their values of input and power and so have scored the last two marks.

ResultsPlus
Examiner Tip

Again, by using word to signpost their answer, candidates can pick up some marks even if they have made a mistake.

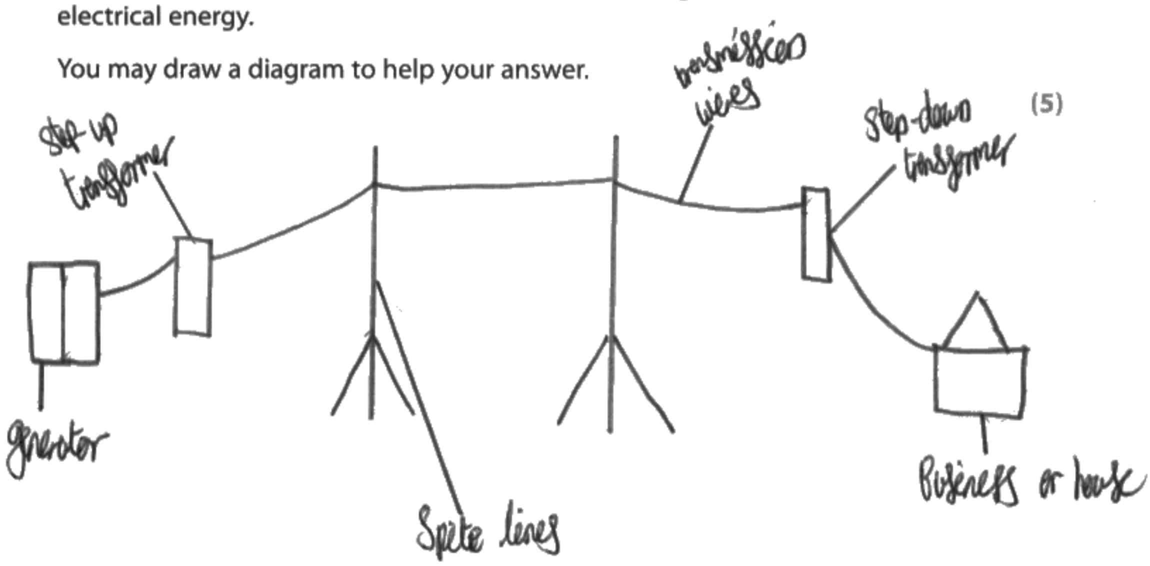
Question 7(b)

A very large proportion of candidates had clearly rehearsed this discussion well. Almost all mentioned step up and step down transformers in the correct context, followed with clear arguments about increasing the voltage and decreasing the current during transmission over long distances. To get all five marks though, however, some made reference to heating, 'less energy lost' or lower voltage for safety was required.

(b) Explain how transformers are used in the efficient, large-scale transmission of electrical energy.

You may draw a diagram to help your answer.

(5)



When electrical energy is made by a generator, it instantly ~~travel~~ goes through a step-up transformer. Here the current is reduced and the voltage is increased, this reduces the amount of energy ~~lost~~ lost as heat during transmission ~~caused~~ caused by friction. The ~~electrical energy~~ electricity is carried high above the ground by wires to prevent ~~any~~ human injury caused by the high voltage. Before ~~re~~ entering homes and businesses, the voltage is reduced to a safer one by a step-down transformer. ~~Here, the trans voltage becomes one that we use in our house and the and current become like the one's~~ This prevents people being ~~elect~~ electrocuted by the high voltage.

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Examiner Comments

A wonderfully clear example worthy of full marks.

Marks have been awarded for using the step-up and step-down transformers in the correct place in the system. These marks are obvious on the fully annotated diagram, scoring marking points 1 and 6.

In the body of text, as the step-up transformer's position in the system has been made clear, the ideas of increasing the voltage and decreasing the current before injection into the grid can be given marking points 2 and 3.

Lines 3-4 scores marking points 4 and 5 for the mention of less energy wasted as heat. The reference to 'electricity' is not a correct idea but not contradictory here.

Lines 8-9 contains the idea of the voltage being decreased for safety after transmission.

So this response included all seven marking points, so the reference to friction in line 5 was ignored.

Question 8(a)

The two acceptable pieces of evidence are the Cosmic Microwave Background Radiation (CMBR) or the red-shift of **galaxies**. We condoned a missing word from CMBR or a missing letter in this series.

Question 8(b)

Another multiple-step calculation. Some candidates scored a maximum of one mark because they had used the wrong wavelength in the denominator for the given formula but had quoted their answer to five significant figures as directed.

Successful candidates made their working very clear, ie they got as far as 2.0834×10^{-10} m for the change in wavelength and stated what that was. They went on to add this to the original wavelength to arrive at the correct answer. A small number of candidates subtracted the wavelength, forgetting that this object is moving away from the Earth.

(b) The galaxy NGC 300 is moving away from the Earth at a speed of 1.44×10^5 m/s.

Hydrogen atoms in NGC 300 emit light with a reference wavelength of 4.3405×10^{-7} m.

Calculate the wavelength of this light when it is detected at Earth.

Give your answer to five significant figures.

[speed of light in a vacuum, $c = 3.00 \times 10^8$ m/s]

(4)

$$\frac{\Delta\lambda}{\text{reference wavelength}} = \frac{v}{c} \qquad \frac{x}{4.3405\times10^{-7}} = \frac{1.44\times10^5}{3.00\times10^8}$$

$$\frac{1.44\times10^5}{3.0\times10^8} \times 4.3405\times10^{-7} = 2.08344\times10^{-10}$$

wavelength = 2.08344×10^{-10} m

ResultsPlus
Examiner Comments

This candidate has confused the change in wavelength with what the question is asking for, ie the wavelength of the red-shifted light. The change in wavelength is correct for two marks and has been presented as the candidate's answer. It has not been rounded to five significant figures so cannot be awarded the fourth marking point.

(b) The galaxy NGC 300 is moving away from the Earth at a speed of 1.44×10^5 m/s.

Hydrogen atoms in NGC 300 emit light with a reference wavelength of 4.3405×10^{-7} m.

Calculate the wavelength of this light when it is detected at Earth.

Give your answer to five significant figures.

[speed of light in a vacuum, $c = 3.00 \times 10^8$ m/s]

(4)

$$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

$\lambda_0 = 4.3405 \times 10^{-7}$

$v = 1.44 \times 10^5$

$c = 3 \times 10^8$

$$\Delta\lambda = \frac{v}{c} \times \lambda_0$$

$$\Delta\lambda = \frac{1.44 \times 10^5}{3 \times 10^8} \times 4.3405 \times 10^{-7} = 2.08344 \times 10^{-10}$$

$2.08344 \times 10^{-10} + 4.3405 \times 10^{-7} = 4.34258 \times 10^{-7}$

wavelength = 4.3426×10^{-7} m

ResultsPlus
Examiner Comments

The candidate has spread their work out carefully here arriving at the correct answer towards the bottom of the response.

The answer line contains the correct answer rounded to five significant figures as instructed - therefore full marks have been awarded.

Question 8(c)

Many candidates successfully made the link between Centaurus A being further away so that it would be moving faster. They then went on to stating the effect on the wavelength, ie it would have a greater red-shift and therefore be longer overall.

Some candidates got the logic backwards and a few made no link to the previous parts of the question at all.

(c) Another galaxy, Centaurus A, is much further away from the Earth than NGC 300.

Explain how the wavelength of light detected from hydrogen atoms in Centaurus A is different from the wavelength of light detected from hydrogen atoms in NGC 300.

(2)

The wavelength of light from hydrogen on Centaurus A will have a longer wavelength when viewed from earth than those emitted by NGC 300. This is because a further galaxy will ~~more~~ produce more red-shifted wavelengths as it is further from earth, and moving faster away.

(Total for Question 8 = 8 marks)

TOTAL FOR PAPER = 70 MARKS

ResultsPlus
Examiner Comments

The question tells the candidates that Centaurus A is much further away from the Earth than NGC 300. It was not necessary to name Centaurus A in the response although many candidates did. The idea of a longer wavelength is present in the first sentence. The idea of greater red-shift for further galaxies is in the second sentence.

This response scored two marks.

(c) Another galaxy, Centaurus A, is much further away from the Earth than NGC 300.

Explain how the wavelength of light detected from hydrogen atoms in Centaurus A is different from the wavelength of light detected from hydrogen atoms in NGC 300.

(2)

- As ~~[illegible]~~ centaurus A is further away, it has experienced red-shift meaning it has moved away from earth.
- As it has moved it's wavelengths of light have been stretched making them longer wavelength and lower frequency than NGC 300.

(Total for Question 8 = 8 marks)

TOTAL FOR PAPER = 70 MARKS

ResultsPlus
Examiner Comments

Although the idea of a longer wavelength is here, the candidate has not mentioned that the further galaxy has experienced *greater* red-shift so the first mark was not awarded.

Paper Summary

Based on their performance on this paper, candidates should:

- Take care when drawing diagrams to add correct labels for all apparatus and draw accurately.
- Ensure that they have either seen or performed the practicals named in the specification where possible. This might include 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 and any additional instructions 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. This includes using particular ideas (such as forces or energy) in your answer.
- Structure multi-step calculations as simply as possible, with words, ideally, 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.
- Be ready to comment on data and suggest improvements to experimental methods.
- Allow time at the end of the examination to check answers carefully and correct basic slips in wording or calculation.

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