

Commentary on candidate evidence

The candidate evidence has achieved the following marks for each question.

Question	Response	Mark available	Mark awarded	Comments
10(a)(i)A	1	3	3	The candidate has selected an appropriate relationship, substituted values correctly and given an acceptable final answer.
10(a)(i)A	2	3	2	The candidate has selected an appropriate relationship and has substituted values correctly. The unit in the final answer however is incorrect and so the mark for the final answer is not awarded.
10(a)(i)A	3	3	2	The candidate has selected an appropriate relationship and has substituted values correctly. The final answer however has an incorrect power of 10.
10(a)(i)B	1	3	3	The candidate has selected an appropriate relationship, substituted values correctly (from (a)(i)A) and given an acceptable final answer.
10(a)(i)B	2	3	3	The candidate has selected an appropriate relationship, substituted values correctly and given the correct final answer.
10(a)(i)B	3	3	1	The candidate has selected an appropriate relationship, but has not substituted values

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				correctly (the substituted value for v is not squared).
10(a)(ii)	1	3	3	The candidate has sketched a smaller circle, in the correct position, with the correct direction shown. The construction of the circle is poor, but this is ignored.
10(a)(ii)	2	3	2	The candidate has sketched a smaller circle, with the correct direction shown. The position of the circle however is incorrect.
10(b)	1	2	0	The candidate's explanation is not in terms of the component of <i>velocity</i> of the particle.
10(b)	2	2	0	The candidate does not explain that the force perpendicular to the direction of motion produces circular motion, or that there is no force acting parallel to the direction of motion.
10(b)	3	2	2	The candidate's explanation is acceptable. It is clear that the candidate's use of the word 'horizontal' refers to the particle moving <i>parallel</i> to the magnetic field.
10(c)	1	2	1	The candidate's explanation of the 'short lifetimes' of particles is taken as equivalent to interaction with the atmosphere, and so is acceptable.

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				The second part of the candidate's explanation involving the equator is incorrect.
10(c)	2	2	2	The candidate's explanation of 'spiral towards the poles' is taken as implying a higher particle density. The decay of the particles and 'most don't make it to sea level' is taken as the equivalent to interaction with the atmosphere and both parts of the explanation are acceptable.
10(c)	3	2	2	The candidate's explanation that 'particles may decay and not reach sea level' is taken as the equivalent to interaction with the atmosphere. The second part of the explanation is correct.
11(a)(i)	1	2	2	The candidate has selected an appropriate relationship, substituted values correctly and stated the given final answer.
11(a)(i)	2	2	1	The candidate has selected an appropriate relationship, but the substitution of values is not sufficiently explicit for the second mark to be awarded.
11(a)(i)	3	2	2	The candidate has selected an appropriate relationship, substituted values correctly and stated the given final answer.

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11(a)(ii)	1	3	1	The candidate has selected an appropriate relationship, but the substitution of values is incorrect as the substituted value for A has not been squared.
11(a)(ii)	2	3	0	The candidate has not selected a relationship appropriate for the calculation of kinetic energy.
11(a)(ii)	3	3	3	The candidate has selected an appropriate relationship, substituted values correctly and given an acceptable final answer.
11(a)(iii)	1	3	2	The shape of the line on the candidate's sketch graph is incorrect, but the line does intercept the horizontal and vertical axes at the correct points.
11(a)(iii)	2	3	1	The shape of the line on the candidate's sketch graph is correct, but the values of the intercepts of the line with the axes have been omitted.
11(a)(iii)	3	3	1	The shape of the line on the candidate's sketch graph is correct, however the values of the intercepts of the line on the horizontal axis are incorrect. In addition, the line extends above the value '1.15' on the vertical axis.

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11(b)(i)	1	1	1	The candidate's statement is acceptable. The negative sign is taken as an indication of the candidate's sign convention.
11(b)(i)	2	1	1	The candidate's statement is correct.
11(b)(i)	3	1	0	The candidate's statement is not acceptable due to the incorrect unit for acceleration.
11(b)(ii)	1	3	3	The candidate has selected an appropriate relationship, substituted values correctly and given the correct final answer. The negative sign is taken as an indication of the candidate's sign convention and is ignored.
11(b)(ii)	2	3	3	The candidate has selected an appropriate relationship, substituted values correctly and given the correct final answer. The negative sign is taken as an indication of the candidate's sign convention and is ignored.
11(b)(ii)	3	3	1	The candidate has selected an appropriate relationship, but the substitution of values is incorrect as the substituted value for ω , -61 , is incorrect. The substitution of $-(61)^2$ would have been acceptable, $'(-61)^2$ is incorrect.

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12(a)(i)	1	1	1	The first sentence in the candidate's response is an acceptable explanation.
12(a)(i)	2	1	1	The candidate's explanation is acceptable.
12(a)(i)	3	1	0	The last part of the candidate's explanation ('and cancels it') is incorrect.
12(a)(ii)	1	2	1	The candidate's description is only partially correct.
12(a)(ii)	2	2	0	The candidate's use of the word 'when' in their description suggests a digital change.
12(a)(ii)	3	2	0	The candidate's description is incorrect.
12(b)(i)	1	2	2	The candidate has correctly substituted values into the given relationship and stated an acceptable final answer.
12(b)(i)	2	2	2	The candidate has correctly substituted values into the given relationship and stated an acceptable final answer.
12(b)(i)	3	2	1	The candidate has correctly substituted values into the given relationship, but has included too many significant figures in the final answer.
12(b)(ii)	1	4	4	The candidate has given acceptable expressions for the percentage uncertainties in length and in frequency. The selection of an appropriate

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				relationship is implied by the correct substitution of the percentage uncertainties, and the correct final answer is given.
12(b)(ii)	2	4	4	The candidate has given acceptable expressions for the percentage uncertainties in length and in frequency. The selection of an appropriate relationship is implied by the correct substitution of the percentage uncertainties, and an acceptable final answer is given.
12(b)(ii)	3	4	3	The candidate has given acceptable expressions for the percentage uncertainties in length and in frequency. The selection of an appropriate relationship is implied by the correct substitution of the percentage uncertainties, but the incorrect use of '2·00', rather than 2·20 means that the mark for the final answer is not awarded.
12(c)(i)	1	3	3	The candidate has implied a relationship to calculate the gradient of the line of best fit, has selected correct co-ordinates, and given an acceptable final answer.
12(c)(i)	2	3	0	The candidate has not attempted to calculate the gradient of the line of best fit. The substitution of values from a single data point into the relationship is wrong physics.

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12(c)(i)	3	3	1	The candidate has implied a relationship to calculate the gradient of the line of best fit, but has not selected correct co-ordinates. The point '(2,700)' does not lie sufficiently close to the line of best fit.
12(c)(ii)A	1	1	1	Although not appreciating that in terms of uncertainties, '2.2%' and '2%' would indicate equal precision, the candidate's statement is acceptable.
12(c)(ii)A	2	1	1	The candidate's statement is correct. Their attempted justification regarding the number of significant figures, while not required, is not incorrect.
12(c)(ii)A	3	1	1	The candidate's statement is consistent with their values carried forward from (b)(ii).
12(c)(ii)B	1	1	1	The candidate's statement is correct.
12(c)(ii)B	2	1	1	The candidate's statement is consistent with their values carried forward from (b)(i).
12(c)(ii)B	3	1	0	The candidate's statement is correct. Their attempted justification regarding lower uncertainty, while not required, is incorrect.
12(c)(iii)	1	1	0	The candidate's suggestion does not sufficiently indicate a

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				<i>measurement</i> as a source of systematic uncertainty.
12(c)(iii)	2	1	0	The candidate's suggestion does not sufficiently indicate a <i>measurement</i> as a source of systematic uncertainty.
12(c)(iii)	3	1	1	The candidate's suggestion indicates a <i>measurement</i> as a source of systematic uncertainty.
13(a)(i)	1	4	1	The candidate has not selected an appropriate relationship, but has correctly shown the substitution to determine Δx .
13(a)(i)	2	4	2	The candidate has selected an appropriate relationship, but has substituted an incorrect value for λ . The correct substitution to determine Δx is shown.
13(a)(i)	3	4	1	The candidate has selected an appropriate relationship, but, in substitution, has confused d with Δx . The marks for substitution into the relationship and for the determination of Δx are not awarded.
13(a)(ii)	1	1	0	The candidate's explanation confuses <i>accuracy</i> and <i>precision</i> , with no reference to the uncertainty in Δx .
13(a)(ii)	2	1	1	The candidate's explanation is acceptable, with the

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				implication of a reduction of the uncertainty in Δx .
13(a)(ii)	3	1	1	The candidate's explanation is correct.
13(b)	1	2	1	The candidate's statement is correct. Their justification, while not incorrect, is not sufficient, with no mention of d and D remaining constant.
13(b)	2	2	2	The candidate's statement is correct. The mention of 'other variables remain constant', <i>and</i> λ increasing, and quoting the relationship, is sufficient justification.
13(b)	3	2	2	The candidate has made a correct statement and justified this by a calculation. This is an appropriate justification.
13(c)(i)	1	3	3	The candidate has selected an appropriate relationship, substituted values correctly and given the correct final answer.
13(c)(i)	2	3	0	The candidate has not selected an appropriate relationship.
13(c)(i)	3	3	1	The candidate has selected an appropriate relationship, but has not substituted values correctly.
13(c)(ii)	1	1	0	The candidate has not determined optical path difference (opd) correctly.

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13(c)(ii)	2	1	1	The candidate has determined optical path difference (opd) correctly.
14(a)(i)	1	2	2	The candidate has selected an appropriate relationship, substituted values correctly and stated the given final answer.
14(a)(i)	2	2	1	The candidate has selected an appropriate relationship, but not explicitly shown the value for ϵ_0 . In addition, the value of r has been squared. Either of these issues result in no mark being awarded for substitution.
14(a)(i)	3		0	The candidate has not selected an appropriate relationship.
14(a)(ii)	1	3	3	The candidate has substituted values correctly, combined potentials and given an acceptable final answer. The candidate has rounded the value of V_2 at an intermediate stage. The rounding is not incorrect, and the final answer is acceptable, so the mark for the final answer is awarded.
14(a)(ii)	2	3	1	The candidate has substituted values for V_2 correctly, but has not attempted anything further.
14(a)(ii)	3	3	1	The candidate has substituted values correctly for $V_{(-)}$. In attempting to combine potentials, the candidate has

Question	Response	Mark available	Mark awarded	Comments
				not used the given value for V_+ (2.4×10^{-3}) from (a)(i).
14(b)	1	2	0	The candidate's statement is correct, but it states that 'the distance between the charges decreases ...' which is wrong physics, and so both marks are not awarded.
14(b)	2	2	0	The candidate's statement is incorrect.
14(b)	3	2	0	The candidate's statement is incorrect.
15(b)(i)	1	3	3	The candidate has stated $V=Ed$, and both stated and equated $F=qvB$ and $F=QE$. The given relationship is also stated.
15(b)(i)	2	3	3	The candidate has stated $V=Ed$, and both stated and equated $F=qvB$ and $F=QE$. The given relationship is also stated.
15(b)(i)	3	3	0	The candidate has shown some confusion, stating $E=vd$ and $V=Ed$, with only one other relationship stated, $F = qvB$, with no equating of forces.
15(b)(ii)	1	2	1	The candidate has substituted values correctly into the given relationship, but has not included a unit in the final answer.
15(b)(ii)	2	2	1	The candidate has substituted values correctly into the given

Question	Response	Mark available	Mark awarded	Comments
				relationship, but has not calculated an acceptable final answer.
15(b)(ii)	3	2	2	The candidate has substituted values correctly into the given relationship, and has calculated the correct final answer.
15(b)(iii)	1	2	2	The candidate's explanation is correct.
15(b)(iii)	2	2	1	The candidate has stated that V increases, but has not explained the cause.
15(b)(iii)	3	2	1	The candidate has stated that V increases. The statement 'causing more charge to gather ...', however, does not imply charge separation.
16(a)(i)	1	1	0	The candidate's circuit is not acceptable – it is missing the symbol for a battery.
16(a)(i)	2	1	0	The candidate's circuit is not acceptable – it has an excessively large gap at the battery.
16(a)(i)	3	1	1	The candidate's circuit is acceptable. The inclusion of the switch does not make the circuit inoperable.
16(a)(ii)	1	2	0	The candidate has incorrectly used '67%' instead of 63%. This is wrong physics.

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16(a)(ii)	2	2	2	The candidate has correctly calculated 63% of 6V, and given an acceptable value for time constant. The candidate's working is not ideal, but is regarded as bad form and is not penalised.
16(a)(ii)	3	2	2	The candidate has not shown their working, but has given the correct value for time constant.
16(a)(iii)	1	3	3	The candidate has selected an appropriate relationship, substituted values correctly, and given an acceptable final answer. The alternative unit is correct.
16(a)(iii)	2	3	1	The candidate has selected an appropriate relationship, but has not substituted values correctly, since the candidate has no value for time constant to carry forward from (a)(ii).
16(a)(iii)	3	3	2	The candidate has selected an appropriate relationship, and substituted values correctly using the value for τ carried forward from (a)(ii), but has neither calculated an acceptable final value, nor given an acceptable unit ($\text{s } \Omega^{-1}$ would have been acceptable).
16(b)(i)	1	3	3	The candidate has selected an appropriate relationship, substituted values correctly, and given an acceptable final

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				answer. The incorrect spelling of henrys is ignored.
16(b)(i)	2	3	1	The candidate has selected an appropriate relationship, but has not substituted values correctly, $\epsilon = -9.0 \text{ V}$.
16(b)(i)	3	3	3	The candidate has selected an appropriate relationship, substituted values correctly, and given an acceptable final answer. The alternative unit is correct.
16(b)(ii)	1	2	2	The candidate's statement is correct, and the justification is sufficient.
16(b)(ii)	2	2	2	The candidate's statement is correct, and the justification is sufficient.
16(b)(ii)	3	2	0	The candidate's statement is correct. The justification, however, contains wrong physics, as 'resistance' should have been <i>reactance</i> .