

## Commentary on candidate responses

The marking issues identified in this document are based on examples that were noted during Quality Assurance and Appeals procedures in Spring/Autumn 2021.

| Question | Candidate response | Max mark | Mark awarded | Commentary  |
|----------|--------------------|----------|--------------|---|
| 1(b)     | A                  | 3        | 0            | The candidate has not selected an appropriate relationship. Following the statement of an inappropriate relationship, a correct relationship cannot be implied by 'correct' substitution of values.                   |
|          | B                  | 3        | 1            | The candidate has selected an appropriate relationship but has not correctly substituted values ( $v = 0$ , $u = -10.7$ ).  |
|          | C                  | 3        | 3            | The candidate has selected an appropriate relationship, correctly substituted values (consistent sign convention), and calculated an acceptable final answer.   |
| 1(c)     | A                  | 3        | 3            | The candidate has selected an appropriate relationship, substituted values consistent with their final answer for 1(a)(i), and given an acceptable final answer.  |
|          | B                  | 3        | 1            | The candidate has selected an appropriate relationship but has not correctly substituted values (10.7 rather than 11.9).  |
| 1(d)     | A                  | 2        | 2            | The candidate has made an acceptable statement ('higher' is an acceptable alternative to 'greater') and has given an acceptable justification ('going faster' is an acceptable alternative to 'has a greater speed'). |
|          | B                  | 2        | 1            | The candidate has made an acceptable statement, but their justification is incomplete, lacking an indication of potential energy being converted to kinetic energy.   |
|          | C                  | 2        | 0            | The candidate has made an incorrect statement. Following an incorrect statement, no marks are awarded for a 'correct' justification.  |
| 2(a)     | A                  | 4        | 1            | The candidate has selected an appropriate relationship but has not correctly substituted values due to incorrect transposition ( $a = \frac{m}{F}$ rather than $a = \frac{F}{m}$ ).                                   |

| Question | Candidate response | Max mark | Mark awarded | Commentary  |
|----------|--------------------|----------|--------------|---|
|          | B                  | 4        | 3            | The candidate has selected an appropriate relationship and has correctly substituted values in both uses of the relationship. The candidate's final answer, however, is not acceptable, due to rounding at the intermediate stage.<br>The mark for the final answer is not awarded. |
| 2(b)(i)  | A                  | 3        | 2            | The candidate has selected an appropriate relationship, and correctly substituted values. The candidate's final answer, however, is not acceptable, due to rounding at the intermediate stage.<br>The mark for the final answer is not awarded.                                     |
|          | B                  | 3        | 1            | The candidate has selected an appropriate relationship but has substituted values into the incorrect version of the selected relationship (presumably $f_o = f_s \left[ \frac{v}{v + v_s} \right]$ rather than $f_o = f_s \left[ \frac{v}{v - v_s} \right]$ ).                      |
| 2(b)(ii) | A                  | 2        | 1            | The candidate has made a correct statement. The language of the justification, while not incorrect, is not sufficiently precise for the second mark to be awarded.  |
|          | B                  | 2        | 1            | Again, this candidate has made a correct statement. The language of the justification, while not incorrect, is not sufficiently precise for the second mark to be awarded.  |
| 3(a)     | A                  | 3        | 1            | The candidate has selected an appropriate relationship but has incorrectly substituted values ( $a$ and $s$ must have the same sign).   |
|          | B                  | 3        | 2            | The candidate has selected an appropriate relationship, correctly substituted values ( $a$ and $s$ have the same sign) but has not given an acceptable final answer (the unit should be $\text{m s}^{-1}$ rather than $\text{m s}^{-2}$ ).  |
|          | C                  | 3        | 3            | The candidate has selected an appropriate relationship, correctly substituted values ( $a$ and $s$ have the same sign) and has given the correct final answer.  |
| 3(b)     | A                  | 3        | 1            | The candidate has selected an appropriate relationship but has incorrectly substituted  |

| Question | Candidate response | Max mark | Mark awarded | Commentary   |
|----------|--------------------|----------|--------------|--|
|          |                    |          |              | values ( $Ft$ and $u$ must have opposite signs).   |
| 3(c)     | A                  | 1        | 0            | The candidate's explanation is not sufficiently precise. <i>Kinetic</i> energy should be specified.  |
|          | B                  | 1        | 0            | The candidate's explanation is not sufficiently precise. 'Goes down' and 'goes up' are not acceptable alternatives to 'decreases' and 'increases'.   |
|          | C                  | 1        | 1            | The candidate's explanation is acceptable.   |
| 3(d)     | A                  | 2        | 0            | '↑' and '↓' are not acceptable alternatives to 'increases' and 'decreases'.  |
|          | B                  | 2        | 1            | The candidate has not specified an increase in time <b>of contact</b> but has specified a decrease in force.   |
| 5(a)     | A                  | 3        | 1            | The candidate has selected an appropriate relationship but has not correctly substituted values ( $G = 6.67 \times 10^{11}$ rather than $G = 6.67 \times 10^{-11}$ ). Following an incorrect substitution, a correct substitution cannot be implied by an acceptable final answer.   |
|          | B                  | 3        | 2            | The candidate has selected an appropriate relationship and correctly substituted values. They have, however, incorrectly rounded the calculated value on the nominator of the vulgar fraction at an intermediate stage (4.814 is incorrectly rounded from 4.8148 ...). Despite a correct final answer, this is treated as an arithmetic error and the mark for the final answer is not awarded.                              |
|          | C                  | 3        | 3            | The candidate has selected an appropriate relationship and correctly substituted values. They have rounded the value on the nominator of the vulgar fraction at an intermediate stage (4.81) but have given the correct final answer. Rounding at an intermediate stage is not good practice but is only penalised if the rounding is incorrect or if correct intermediate rounding results in an unacceptable final answer. |
| 5(b)(i)  | A                  | 1        | 1            | The candidate has given an acceptable alternative explanation.   |
|          | B                  | 1        | 0            | The candidate's explanation is incorrect.  |

| Question | Candidate response | Max mark | Mark awarded | Commentary  |
|----------|--------------------|----------|--------------|---|
|          | C                  | 1        | 0            | The candidate's explanation is not sufficiently precise.  |
| 6(a)(i)  | A                  | 3        | 1            | The candidate has implied the selection of an appropriate relationship ( $\Delta E = hf$ ). However, as the candidate has not shown all substituted values (no value for h) and given an incorrect final answer, correct substitution into $\Delta E = hf$ cannot be implied by the incorrect final answer. |
|          | B                  | 3        | 3            | The candidate has selected an appropriate relationship, correctly substituted values (it is assumed that the two negative signs applied to $5.45 \times 10^{-19}$ have been 'cancelled') and given an acceptable final answer.  |
| 6(b)     | A                  | 3        | 2            | The candidate has selected an appropriate relationship and has correctly substituted values. The final answer, however, is incorrect (0.01503 rather than 0.01500).   |
| 6(c)     | A                  | 2        | 1            | The candidate has implied, but not specifically used the term 'Expanding Universe' and so is awarded the first mark referenced in the marking instructions but not the second.  |
|          | B                  | 2        | 1            | Again, this candidate has implied, but not specifically used the term 'Expanding Universe' and so is awarded the first mark referenced in the marking instructions but not the second.  |
|          | C                  | 2        | 0            | The candidate has not sufficiently explained that redshift implies galaxies moving away from each other.  |
| 7(a)(i)  | A                  | 1        | 0            | The candidate's explanation is insufficient for the mark to be awarded. The statement 'in a straight line' is not an acceptable alternative for 'in the same direction'.  |
|          | B                  | 1        | 1            | The use of 'repelled' in the candidate's explanation implies that, without an alternating supply voltage, the force on the hydrogen ion would not be in the same direction.   |
| 7(a)(ii) | A                  | 1        | 1            | The candidate's suggestion is an acceptable alternative to 'they travel further in the same time'.  |
|          | B                  | 1        | 0            | The candidate's suggestion is incorrect.  |

| Question | Candidate response | Max mark | Mark awarded | Commentary   |
|----------|--------------------|----------|--------------|--|
| 7(b)     | A                  | 3        | 1            | The candidate has selected an appropriate relationship but has not correctly substituted values ( $0.5c^2$ rather than $(0.5c)^2$ ).   |
|          | B                  | 3        | 2            | The candidate has selected appropriate relationships and has correctly substituted values. The candidate has given the final answer to an unacceptable number of significant figures (sig figs), (correct final answer to 2 sig figs, acceptable final answers to 1, 3 or 4 sig figs). |
| 8(a)     | A                  | 1        | 1            | The candidate has given an acceptable alternative explanation. Although 'work function' is not specifically mentioned, the process is satisfactorily described.  |
| 8(b)(ii) | A                  | 2        | 1            | The candidate has selected an appropriate relationship and has correctly substituted values. Although the candidate has stated the given final answer, the penultimate line is an incorrect final answer, which has not been scored out.   |
| 9(a)(i)  | A                  | 2        | 1            | The candidate has correctly substituted values but rounding of the intermediate calculation has resulted in an unacceptable final answer.  |
|          | B                  | 2        | 1            | The candidate has correctly substituted values but has given the final answer rounded to an unacceptable number of significant figures (correct final answer to 3 sig figs, acceptable final answers to 2, 4 or 5 sig figs).   |
| 9(a)(ii) | A                  | 1        | 1            | The candidate's explanation implies that the unbalanced force in the sideways direction is 0 N.  |
| 9(b)(i)  | A                  | 5        | 2            | The candidate has selected an appropriate first relationship but has incorrectly substituted values ( $1.42 \times 10^{-5}$ rather than $1.24 \times 10^{-5}$ ).<br>The mark allocated for the selection of an appropriate second relationship can be awarded.                         |
| 9(b)(ii) | A                  | 3        | 2            | The candidate has substituted values of $I$ and $d$ and correctly calculated the four values of $I \times d^2$ .   |

| Question     | Candidate response | Max mark | Mark awarded | Commentary   |
|--------------|--------------------|----------|--------------|--|
|              |                    |          |              | The statement 'as the results are all similar' does not sufficiently imply ' $I \times d^2 = \text{constant}$ '.   |
|              | B                  | 3        | 2            | The candidate has substituted values of $I$ and $d$ and correctly calculated the four values of $I \times d^2$ .<br>The calculation of a mean value is not a valid analysis when different values of the independent variable are used in the calculation.   |
| 9(b)(iii)(A) | A                  | 1        | 1            | The candidate's statement is acceptable.   |
| 9(b)(iii)(B) | A                  | 3        | 1            | The candidate's explanation does not specify either electrons moving from the conduction band of the n-type semiconductor towards the conduction band of the p-type semiconductor or photons being emitted.<br>The statement 'electrons ...drop energy levels and fill slots in the valence band' is sufficient for the second mark specified in the marking instructions to be awarded. |
|              | B                  | 3        | 0            | The candidate's explanation does not refer either to conduction band or valence band. The mark for specifying the emission of photons is not accessible.   |
| 10(a)(i)(B)  | A                  | 2        | 1            | The substitution of values to calculate the uncertainty is correct. The final answer, however, lacks a unit ( $^{\circ}$ ).  |
| 10(b)        | A                  | 1        | 0            | The candidate's explanation does not specify that the path difference is zero for all wavelengths/frequency/colour, and the last part of the explanation is unclear.   |
|              | B                  | 1        | 0            | The meaning of the candidate's explanation is unclear. By using 'defract', it is also unclear whether the candidate is referring to diffraction or refraction.   |
| 12(b)        | A                  | 1        | 0            | The path of the refracted ray drawn by the candidate does not articulate with the incident ray.  |
|              | B                  | 1        | 1            | The path of the refracted ray drawn by the candidate appears to have been drawn freehand. The path is at a smaller angle of refraction and is passably straight.   |

| Question  | Candidate response | Max mark | Mark awarded | Commentary  |
|-----------|--------------------|----------|--------------|---|
|           | C                  | 1        | 0            | The path of the refracted ray drawn by the candidate appears to have been drawn freehand. The path is at a smaller angle of refraction but is not passably straight.  |
|           | D                  | 1        | 1            | The path of the refracted ray drawn by the candidate is at a smaller angle of refraction. It is shown emerging from the prism, but this section of the path is ignored.   |
|           | E                  | 1        | 1            | The path of the refracted ray drawn by the candidate is at a smaller angle of refraction. It is shown emerging from the prism incorrectly, but this section of the path is ignored.   |
|           |                    |          |              |   |
| 12(c)     | A                  | 2        | 0            | The candidate's explanation refers to wavelength rather than frequency, which is incorrect.<br>Refractive index is frequency dependent not wavelength or wave speed dependent.  |
|           | B                  | 2        | 0            | The candidate's explanation refers to wavelength rather than frequency, which is incorrect.<br>Refractive index is frequency dependent not wavelength or wave speed dependent.  |
|           |                    |          |              |   |
| 13(a)     | A                  | 1        | 1            | The candidate has satisfactorily stated what is meant by AC in diagrammatical form.   |
|           | B                  | 1        | 0            | The candidate's statement does not refer to change in direction and value with time.  |
|           | C                  | 1        | 0            | The candidate's statement does not refer to change in value with time.  |
|           |                    |          |              |   |
| 13(b)(ii) | A                  | 3        | 1            | The candidate has selected an appropriate relationship but has not correctly substituted values ( $0.4$ rather than $4 \times 10^{-3}$ ).   |
|           | B                  | 3        | 2            | The candidate has selected an appropriate relationship and has correctly substituted values, assuming $T$ in milliseconds. The unit in the final answer, however, is not consistent with this assumption, and so the mark allocated to the final answer is not awarded. |
|           |                    |          |              |   |
| 13(c)     | A                  | 2        | 1            | The trace drawn by the candidate shows the same frequency and peak voltage but is not sufficiently sinusoidal to show half-wave rectification of the given trace.   |
|           | B                  | 2        | 2            | The trace drawn by the candidate shows the same frequency and peak voltage and shows half-wave rectification of the given trace.  |

| Question | Candidate response | Max mark | Mark awarded | Commentary   |
|----------|--------------------|----------|--------------|--|
| 14(a)    | A                  | 3        | 1            | The candidate's description covers the variation in resistance to take readings of $V$ and $I$ but does not specify drawing a graph of $V$ against $I$ , and, assuming a graph of $V$ against $I$ was intended, it incorrectly states that the gradient gives $r$ (should be $-r$ ). |
| 14(b)(i) | A                  | 1        | 0            | The candidate's statement is unclear.  |
|          | B                  | 1        | 0            | In the diagram drawn by the candidate, the reading on the voltmeter would be the EMF of 1.5 V, but the diagram does not indicate what is meant by this.  |
| 14(c)    | A                  | 3        | 2            | The candidate's statement is correct, and the candidate has given an acceptable alternative justification, which is incomplete (no mention of current being less).   |
|          | B                  | 3        | 0            | The candidate's statement is incorrect. Following an incorrect statement, a 'correct' justification would not be consistent with the statement and is awarded 0 marks.   |
| 15(a)    | A                  | 2        | 1            | The candidate's explanation covers the increase in frictional force with speed and indicates that terminal velocity is reached when drag and weight are equal but does not state either 'equal and opposite' or 'balanced'.  |
|          | B                  | 2        | 0            | The candidate's explanation covers the point that terminal velocity is reached when the forces acting are balanced but does not identify the forces or indicate the increase in drag with speed.   |