| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1 a | **7** minutes scores [3]<br><br>**but if answer incorrect or incomplete then:**<br><br>$\frac{1{,}680{,}000 \times 2}{8{,}000}$ or 420 scores [2]<br><br>**but if no marks scored then:**<br><br>either use of correct average speed, 4000 or 210 or 3.5 minutes scores [1] | 3 | 7 **seconds** scores [2]<br><br>**Ignore** units |
| b i | **lower speed** (than 8000m/s) then:<br>- centripetal / gravitational force too high (to stay in this orbit) [1]<br>- rocket may fall / move or spiral to Earth [1]<br><br>**higher speed** (than 8000m/s) then:<br>- centripetal / gravitational force too low (to stay in this orbit) [1]<br>- rocket may move away from Earth / spiral out of orbit [1]<br><br>(idea of) higher stable orbits experience lower gravitational force or lower speed / ORA [1] | 3 | **Eg.** rocket may fall as centripetal / gravitational force is too big [2]<br><br>**eg.** rocket may move away as centripetal / gravitational force is too small [2]<br><br>**allow** any idea that correct speed needed to allow correct angle of re-entry to avoid overheating [1] |

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|---|---|---|---|
| ii | (+/-) 4 ($m/s^2$) scores [3]<br><br>**but if answer is incorrect then:**<br><br>(+/-) $\frac{(120^2 - 2000^2)}{2 \times 5 \times 10^5}$ [2]<br><br>**Or if no other marks scored then**<br><br>evidence of correct substitution into $v^2 = u^2 + 2as$<br><br>**or** evidence of **rearranged** formula: $\frac{v^2 - u^2}{2s}$ [1] | 3 | **allow** 3.99 **/** 3.9856 ($m/s^2$) [3] |
| c i | share expertise / knowledge / data / workload interpretations of evidence [1]<br><br>check / test / compare (each other's) results [1] | 1 | **Eg.** work / ideas can be shared [1]<br>**Eg.** more data collected [1]<br>**Eg.** more / different jobs can be done (at same time) [1]<br>**Eg**. Idea of international collaboration / sharing cost [1] |
| ii | other scientists can check or test or verify findings / develop ideas or theories / use or compare the data / improve knowledge or education / more data available / credit or acknowledgement of work [1] | 1 | **allow** (idea of) peer review [1] |
| | **Total** | **11** | |

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|---|---|---|---|
| 2 a | Maximum range (achieved) at $45^0$ [1]<br><br>**BUT**<br><br>Range rises with angle until $45^0$ then falls [2] | 2 | **Ignore** references to height<br><br>eg 'the further away from $45^0$ the lower the range scores' [2]<br><br>**if no marks awarded:**<br>**allow EITHER** 'rises and falls' **OR** 'as the angle increases the range decreases' [1]<br>eg 'range goes up and then goes down' [1] |
| b | $90^0$ [1] | 1 | **allow** vertical / AW [1]<br>**allow** suitable annotation of the diagram |
| c i | Parabolic / parabola [1] | 1 | **ignore** curve / arc / arch on its own<br>**ignore** trajectory |
| ii | (Vertical / upward) velocity decreases [1]<br><br>Acceleration (remains) constant / AW [1] | 2 | Mark points independently:<br>eg. vertical velocity and acceleration are reduced for a maximum of [1]<br><br>eg. vertical velocity and acceleration are constant for a maximum of [1] |
| iii | no effect (by gravity) / AW [1] | 1 | **Allow** doesn't (change) [1]<br>**Allow** (Stays) constant [1] |
| | **Total** | **7** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 3 | (a | | cruising speed = 10 (m/s) (2)<br><br>**but if answer is incorrect**<br><br>30 = (v/2) x 6 **or** (2 x 30) ÷ 6 or 60 ÷ 6 (1)<br><br>**then** if a correct calculation is given:<br><br>Samuel / he is not correct (it is twice as fast) (1) | 3 | If answer says that cruising speed = 30 / 6 = 5 **AND** that Sam is correct (1).<br>**OR**<br>**allow** Samuel has calculated the **average speed** (5m/s) (1) |
| | **(b)** | | between 0 and X is longer time than between Y and Z / AW / ORA (1)<br><br>between 0 and X is lower acceleration than between Y and Z / AW / ORA (1)<br><br>between 0 and X is acceleration but between Y and Z is deceleration or negative acceleration (1) | 2 | **allow** it is getting faster between O and X **but** slower between Y and Z (1)<br>**ignore** just acceleration between Y and Z.<br>**ignore** 'faster' acceleration / deceleration<br><br>**allow** correct calculations to illustrate the marking points.<br>Eg. 10/6 (1.67) compared to 10/2 (-5) (2)<br><br>**allow** ecf for a correct calculation. Eg. 5/6 (0.83) compared to 5/2 (-2.5) (2)<br><br>**allow** deceleration is 3 times greater / AW (2) |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | (c) | (i) | 108000 (W) (2)<br><br>**but if answer is incorrect**<br><br>(6000 + {8 x 600}) x 10 or (6000 + 4800) x 10 or 10800 x 10 (1) | 2 | **allow** ecf for incorrect cruising speed in 1(a) |
| | | (ii) | 1100 (kg) (2)<br><br>**but if answer is incorrect**<br><br>(6000 + {8 x 600}) ÷ 9.8 or (6000 + 4800) ÷ 9.8 or 10800 ÷ 9.8 (1) | 2 | 1102.(0408) (1) |
| | | | **Total** | **9** | |