| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1 | **Level 3: (5 – 6 marks)**<br>Answer shows qualitative understanding in terms of forces and momentum **AND**<br>a full mathematical understanding of the 'explosion' idea.<br>Quality of written communication does not impede communication of the science at this level.<br><br>**Level 2: (3 – 4 marks)**<br>Answer shows a qualitative understanding in terms of **either** forces or momentum.<br>**OR**<br>A correct mathematical answer showing both have equal momentum.<br>Quality of written communication partly impedes communication of the science at this level.<br><br>**Level 1: (1 – 2 marks)**<br>Answer indicates a simple idea of equal and opposite forces **OR** momentum.<br>Quality of written communication impedes communication of the science at this level.<br><br>**Level 0: (0 marks)**<br>Insufficient or irrelevant science. Answer not worthyof credit. | 6 | This question is targeted up grade A*<br><br>**Indicative scientific points may include:**<br><br>**Qualitative understanding**<br>• Both have same momentum<br>• Same force produces higher acceleration on Nina but less on Matt because he has more mass<br>• Nina has less mass so more speed and Matt has more mass and less speed (level 3)<br>• Force produces different speeds on different masses (level 2)<br>• Momentum before and after is the same<br><br>**Mathematical understanding**<br>• Momentum before and after is zero (level 3)<br>• 60 x -5 + 100 x 3 = 0 (level 3)<br>• 0 = (60 x -5) + (100 x 3) (level 3)<br>• 0 = -300 + 300 (level 3)<br>• 60 x 5 = 100 x 3 (level 2)<br>• 300 = 300 (level 2)<br><br>**Level 1:**<br>• Forces are equal and opposite<br>• Momentum is conserved<br><br>Use the L1, L2, L3 annotations in Scoris; do not use ticks. |
| | **Total** | **6** | |

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|---|---|---|---|---|---|
| 2 | (a) | | **vector** **scalar**<br>velocity mass<br>weight speed<br>momentum<br>(1) (1) | 2 | all three needed<br><br>both needed<br><br>if no marks scored 2 scalar **and** 2 vector correct scores (1)<br>eg.<br>**vector** **scalar**<br><br>**velocity** **mass**<br>**weight** **speed**<br>*momentum* **X**<br>scores (1) |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| | **(b)** | | 56 (m / s) (1) | 1 | |
| | **(c)** | | 180 (m) (2)<br><br>**but if answer is incorrect**<br><br>{(56 + 4) / 2} x 6 scores (1) | 2 | Allow 178 to 182. (2)<br><br>**allow** e.c.f. from (b)<br>eg. 57 (m), 96(m) or 102(m) scores (2) |
| | | | **Total** | **5** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 3 | (a | | **A – (acceleration section)**<br>acceleration because weight is greater than drag (1)<br>OR<br>acceleration reduces because drag increases (1)<br><br>**B – (terminal speed section)**<br>terminal speed because weight = drag (1)<br>OR<br>forces are equal and opposite/balanced (1)<br><br>**C - (deceleration section)**<br>decelerating as drag increases (greatly) (1)<br>OR<br>decelerating as drag now greater than weight (1)<br><br>**D – (**(lower) **terminal speed section)**<br>drag = weight (1)<br>**OR**<br>forces are equal and opposite/balanced (1) | 4 | for max marks (4) the links must be there on all four points<br>e.g. part A – acceleration **because** weight is greater than drag (1)<br><br>without links max (2) for correctly describing the motion OR the forces in the 4 sections<br><br>without links max (1) for correctly describing the motion OR the forces in 2 or 3 sections<br><br>**ignore** gravity (rather than weight)<br>**ignore** upthrust<br>**ignore** GPE and KE<br><br>**allow** air resistance / friction (rather than drag)<br><br>**allow** for terminal speed – steady / constant speed<br>**allow** for acceleration – increasing speed<br>**allow** for deceleration – decreasing speed<br><br>**allow** negative acceleration (for deceleration)<br><br>**Three links plus one description scores 3**<br>**Two links and two descriptions scores 3**<br>**Two links and one description scores 2**<br>**One link and two or three descriptions scores 2**<br>**One link and one description scores 1**<br>**The links and the descriptions must be from different sections.** |

<table>
<tr><th colspan="3">Question</th><th>answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><td>At A all of Susie’s energy is GPE.</td><td>(✓)</td></tr>
<tr><td>Between A and B Susie gains both GPE and KE.</td><td>✖</td></tr>
<tr><td>Between A and B Susie gains only KE.</td><td>✓</td></tr>
<tr><td>At B her KE is exactly half her GPE at A.</td><td>✖</td></tr>
<tr><td>Just before touching the ground at C Susie has her maximum KE.</td><td>✓</td></tr>
<tr><td>On the ground at C Susie has zero KE.</td><td>✓</td></tr>
<tr><td>On the ground at C Susie has her maximum GPE.</td><td>✖</td></tr>
</table>
</td><td>3</td><td>Use marking tool on scoris to identify the crosses<br><br>all 6 correct (3)<br><br>4 or 5 correct (2)<br><br>2 or 3 correct (1)<br><br>only 1 correct (0)<br><br>ignore blank boxes</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
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| Question | | | answer | Marks | Guidance |
|---|---|---|---|---|---|
| 4 | (a) | | drag less than weight (1) | 1 | **allow** air resistance or friction for drag<br>**allow upward** force less than **downward** force (1)<br>forces unbalanced (0)<br>**but** unbalanced (resultant) force downwards (1)<br>**ignore** gravity but **allow** gravitational force<br>eg gravity more than drag (0) |
| | (b) | | drag = weight (1) | 1 | **allow** (upward and downward) forces balanced (1)<br>**allow** no resultant force / AW (1)<br><br>**ignore** gravity but **allow** gravitational force<br>eg Gravity = drag (0) |
| | (c) | | drag (much) greater than weight (1) | 1 | **allow** upward force is (much) greater than the downward force<br>**but** not merely forces are unbalanced<br><br>**allow** surface area increases drag (1) |
| | (d) | | **any two from:**<br>large surface area / more particles hit (per sec) = more drag (1)<br><br>surface area to weight ratio has increased (1)<br><br>drag = weight **at a lower speed** (1)<br><br>as speed reduces drag reduces until it equals the weight (1) | 2 | eg 'larger area parachute has drag = weight at a lower speed' (2)<br><br>**allow** forces balanced at a lower speed (1) |
| | (e) | | more drag needed to balance higher weight / AW (1)<br><br>the drag (needed for balance) reached at a higher speed (than before) / AW (1) | 2 | heavier person will need a larger air resistance (1)<br>**ignore** references to energy |
| | | | **Total** | **7** | |

| Question | | | answer | Marks | Guidance |
|---|---|---|---|---|---|
| 5 | | | Statement<br>all sheets..<br>the weight of..<br>the time to...<br>the drag on A >…<br>at terminal speed…. | 2 | three correct = [2]<br>one or two correct = [1]<br>any additional tick over three: minus one to minimum of zero |
| | | | **Total** | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| **6 a** | 9.8 (m) or $\frac{1}{2}$ x 14 x 1.4 (2)<br><br>**but if incorrect allow** attempt at calculating area under the graph (1) | 2 | <br><br>**Eg** shown on graph by shading / AW [1]<br><br>**If no other marks scored then allow** 14 x 1.4 or 19.6 [1] |
| **b i** | instantaneous deceleration at point P is (more representative of) when diver enters water [1]<br><br>idea of ignoring anomalous results / point Q is not on the line / (1)<br><br>Elaine's method covers more data / more appropriate data / AW [1]<br><br>(gradient gives a more) accurate result (1) | 2 | **allow** Q is (some time) after diver enters water [1]<br>allow deceleration / acceleration changes (after P) [1]<br><br>**eg** point Q is anomalous [1] |
| **b ii** | 1200 (N) (1) | 1 | **Allow** -1200 (N) [1] |
| | **Total** | **5** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7 a | 11.25 m (3)<br><br>**but if incorrect**<br><br>56.25 = 5 x h (2)<br><br>**but if incorrect**<br><br>KE = ½ x 0.5 x 15 x 15 (1)<br><br>**or**<br><br>m g h = ½ m $v^2$ / PE = KE (1) | 3 | <br><br>**allow** 56 = 5h (2)<br><br>11.25 (3)<br><br>**if incorrect**<br>time = 1.5 (seconds)(1)<br><br>average speed = 7.5 (1)<br><br>**allow** other correct calculations using equations of motion |
| b | **any one from**<br><br>(idea that the) mass cancels out on the equation (1)<br><br>(idea that without air resistance) both masses have the same acceleration (and so reach the same speed in the same time) (1) | 1 | |
| | **Total** | **4** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 8 | (a) | ( | **any one from:**<br>fewer pedestrians / cyclists killed compared to car occupants (1)<br><br>fewer pedestrians / cyclists killed compared to previous year(s) (1) | 1 | **allow** ratio or proportion going down<br>**ignore** descriptions of graph<br>eg trend or graph is down / negative correlation<br><br>**ignore** answers which simply reword the question<br><br>**ignore** references to pedestrian : cyclist ratio |
| | | (ii) | **any two from:**<br>data does not distinguish pedestrians from cyclists (1)<br><br>total numbers of deaths for cars not shown (1)<br><br>total numbers of deaths for pedestrians not shown (1)<br><br>total numbers of deaths for cyclists not shown (1) | 2 | <br><br><br><br>**allow** 'ratio of cyclist deaths compared to pedestrian deaths not known' (2)<br><br>**allow** 'total number of deaths for each group unknown' (2) |
| | (b) | | **any two from:**<br>longer time (to stop) (1)<br><br>less acceleration (1)<br><br>less force produced (1)<br><br>**but** lower rate of change of momentum produced (2) | 2 | <br><br>eg 'Slow down the speed of the passengers more slowly' (1)<br><br><br><br>**allow** slow down = longer time unless answer shows otherwise<br>eg slow down the change of momentum (1)<br>eg the change in momentum takes longer (1)<br>**but** slow down the rate of change of momentum (0) (as you cannot 'slow down a rate')<br>**allow** reduce the rate of change of momentum (2)<br><br>**ignore** references to energy<br>**but** energy absorbed (0) over a longer time (1) |
| | | | **Total** | **5** | |