# Mark scheme

| Question | | | Answer/Indicative content | Marks | Guidance |
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| 1 | a | i | 3 m / $s^2$ ✓ | 1 (AO 1.2) | **Examiner's Comments**<br><br>Most candidates incorrectly estimated 50 m / $s^2$. |
| | | ii | **First check the answer on the answer line**<br>**If answer = 5 400 (N) award 2 marks**<br><br>(F =) 1800 x (a)(i) ✓<br><br>(F =) 5400 (N) ✓ | 2 (2 × AO 2.1) | **ECF** from (a)(i)<br><br>If a = 50 (m / $s^2$), F = 90 000 (N) ✓<br>If a = 100 (m / $s^2$), F = 180 000 (N) ✓<br><br>**Examiner's Comments**<br><br>Most of the candidates gained 2 marks, multiplying the mass by their estimate for the acceleration. |
| | b | | **First check the answer on the answer line**<br>**If answer = 120 (m / $s^2$) award 2 marks**<br><br>(deceleration =) 18 ÷ 0.15 ✓<br><br>(deceleration =) 120 (m / $s^2$) ✓ | 2 (2 × AO 2.1) | **IGNORE** "-"<br><br>**Examiner's Comments**<br><br>Most candidates correctly substituted the data into the given equation.<br><br>A number of lower-scoring candidates incorrectly multiplied velocity by the time. |
| | c | i | **Any three from:**<br><br>Probability increases (as change in velocity increases) / **ORA** ✓<br><br>Changes from 0.1 to 0.9 or change by 0.8 **or** 9 times greater✓<br><br>Probability changes more rapidly at low change in velocity / **ORA** ✓<br><br>Relationship is non-linear / not proportional ✓ | 3 (3 × AO 3.1b) | **ALLOW** an alternative for the first two marking points<br>probability increases from 0.1 to 0.9 or increases by 0.8 for two marks ✓✓<br><br>**Examiner's Comments**<br><br>Most of the candidates scored 2 marks, often describing that the probability increased as the speed increased and using the graph to determine that the change in probability was 0.8. A few candidates described extra details, such as the increase not being linear or proportional. To gain full credit candidates also needed to describe the initial curved section of the line. |
| | | ii | 26(.0) to 27.5 m / s ✓ | 1 (AO 2.2) | **Examiner's Comments** |

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| | | | | | This question required candidates to understand that to definitely cause serious injury, the probability needed to be equal to 1.<br><br>Candidates found this question challenging, with only a minority of candidates correctly reading off the value of speed when the probability reached 1. |
| | | | **Total** | **9** | |
| 2 | | i | Handle the radioactive isotope using tongs. ☐<br>Move the radioactive isotope further away from the detector. ☐<br>Place lead in front of the radioactive isotope. ☐<br>Zero the counter and take another reading. ☑<br>✓ | 1 (AO 3.3b) | **Examiner's Comments**<br><br>Most of the candidates correctly identified that the last box was the correct answer. Across the range of marks other answers were observed.<br><br>This was a question where candidates should be advised to read each statement and place a small cross to eliminate an incorrect statement. |
| | | ii | 8 (counts per second) ✓ | 1 (AO 1.2) | **ALLOW** 7.9(1) (candidate has subtracted 5 from activity in cpm)<br><br>**Examiner's Comments**<br><br>Most of the candidates gained the correct answer by dividing 480 by 60. A significant proportion of the candidates incorrectly multiplied 480 by 60. |
| | | | **Total** | **2** | |
| 3 | | | 0.06(0) (kW) ✓ | 1 (AO 1.2) | **Examiner's Comments**<br><br>This was well answered. A common incorrect answer was 0.6 kW. |
| | | | **Total** | **1** | |
| 4 | | | D | 1 (AO 1.1) | **Examiner's Comments**<br><br>This question was answered well. |
| | | | **Total** | **1** | |
| 5 | | | C | 1 (AO 2.2) | **Examiner's Comments**<br><br>Although the majority of the candidates correctly identified that it took 1 second for the drive to react |

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| | | | | | there were many incorrect responses.<br><br>Distractor B was often chosen, perhaps indicating that the graph was not correctly interpreted.<br>Candidates should be encouraged to read all the responses eliminating those that are wrong. Then carefully looking at the remaining responses. A number of candidates chose A, perhaps not understanding the terms 'brake' and 'react'. |
| | | | **Total** | **1** | |
| 6 | a | | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 0.5 − 3.0 (m / $s^2$) award 3 marks**<br><br>Estimate for time = 2 − 12 seconds ✓<br><br>Acceleration = 6 ÷ their estimate of time ✓<br><br>(Acceleration =) 0.5 − 3(.0) m / $s^2$ ✓ | 3<br>(3 × AO2.1) | **Examiner's Comments**<br><br>This question required candidates to estimate the time it would take for a student cyclist to accelerate to 6 m/s. Many candidates incorrectly suggested a time of one second. |
| | b | i | Use a tape-measure / trundle wheel ✓ | 1<br>(AO1.2) | **IGNORE** ruler<br>**ALLOW** metre rule / stick<br><br>**Examiner's Comments**<br><br>This question was well answered. Some candidates incorrectly suggested the use of a ruler. For distances larger than one metre, candidates should be suggesting to use a tape measure or trundle wheel. |
| | | ii | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 6.0 (m) award 2 marks**<br><br>Mean = (4.4 + 8.0 + 5.6) ÷ 3 ✓<br>(Mean =) 6.0 (m) ✓ | 2<br>(2 × AO1.2) | **ALLOW** 8(.0) is an anomaly so<br>Mean = (4.4 + 5.6) ÷ 2 ✓<br>(Mean =) 5(.0) (m) ✓ working must be seen<br><br>**ALLOW** 6 (m)<br><br>**Examiner's Comments**<br><br>This question was generally well answered. Most candidates added the three distances together and divided by three.<br><br>Marks were also given for responses that omitted the distance of 8.0 m and |

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| | | | | | treated this distance as an anomaly. This is where it is essential to see working from candidates. |
| | | iii | **Any one from**:<br>They did not use the same force when braking / AW ✓<br><br>They did not measure height to the same part of the bike each time ✓<br><br>They did not start at the same place on the ramp ✓<br><br>They did not apply the brakes at the same place / time ✓ | 1<br>(AO3.2a) | **ALLOW** wind may affect braking<br><br>**IGNORE** They did not measure distance correctly.<br>**IGNORE** They used the pedals (instead of freewheeling)<br>**IGNORE** reaction time / human error<br><br>**Examiner's Comments**<br><br>Vague answers such as 'reaction time' were not given marks. It is expected such candidates should relate their answers to the experiment described in the question. Many candidates discussed different braking forces or not applying the brakes in the same position each time |
| | c | i | 11(m) ✓ | 1<br>(AO2.2) | **Examiner's Comments**<br><br>The majority of the candidates gained an answer of 11m. A common error was to record the braking distance as 12 m. |
| | | ii | Use of data to show as speed increases, braking distance increases ✓<br>**OR**<br>(As speed increases,) (braking) distance increases ✓<br><br>At higher speeds more likely to hit an obstacle (in front) as you travel further before stopping / cause more damage / AW ✓ | 2<br>(AO3.1a)<br>(AO3.1b) | **Example**<br>at 1m/s, bd = 1m but at 2m/s, bd = 4m.<br><br>**ALLOW** stopping for braking<br>**ALLOW** longer time to stop<br><br>**Examiner's Comments**<br><br>Many candidates explained that the braking distance increased as the speed increased and demonstrated this using data. Few candidates were able to explain why this was more dangerous. |
| | | iii | **Any one from**:<br><br>Repeat for more speeds / heights ✓<br><br>Make sure constant force when braking / press brakes by same amount each time / AW ✓ | 1<br>(AO3.3b) | **IGNORE** repeats experiment / averages results<br><br>**Examiner's Comments**<br><br>Candidates needed to suggest improvements linked to the investigation. In this investigation, sensible improvements included |

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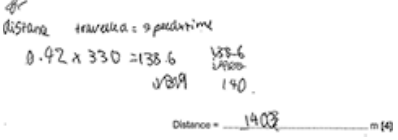
| | | | | | repeating the experiment for different speeds and ensuring that the brakes were pressed by the same amount at the same position for each experiment. |
| | d | | Increases ✓ | 1 (AO1.1) | **Examiner's Comments**<br><br>Many candidates did not understand that increasing the mass of the bicycle meant that the cyclist would have a larger kinetic energy and more work would be needed to be done to bring the cyclist to a stop. For the same braking force this would mean a larger braking distance. |
| | | | **Total** | **12** | |
| 7 | a | | Speed of light is (much) higher than speed of sound **/ AW** ✓ | 1 (AO1.1) | **Examiner's Comments**<br><br>The majority of the candidates were able to state that the speed of light is (much) faster than the speed of sound. This question required a comparison. |
| | b | | **FIRST CHECK THE ANSWER ON ANSWER LINE**<br>**If answer = 140 (m) award 4 marks**<br><br>distance travelled = speed × time ✓<br>(distance travelled =) 330 × 0.42 ✓<br>(distance travelled =) 138.6 or 139 ✓<br>(distance travelled =) 140 (m) (to 2sf) ✓ | 4 (AO1.2) (AO2.1) (AO2.1) (AO1.2) | **Examiner's Comments**<br><br>The majority of candidates were able to calculate the distance. Of these candidates, just over half were able to correctly round the distance to two significant figures.<br><br>One common error was the rounding of 138 to 14 (omitting the zero).<br><br>Exemplar 1<br>  <br><br><br>This candidate has demonstrated how to respond to a calculation question well.<br><br>The candidate has written the equation that is to be used (in this case from the data sheet).<br><br>Then the correct numbers from the question have been substituted. The candidate when reading the question |

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| | | | | | has underlined the numerical data values.<br><br>Then the candidate has evaluated the equation and written the answer displayed by the calculator 138.6 – this response would have scored the candidate 3 marks. The candidate then correctly rounds the response to two significant figures. |
| | c | | Idea time measured is incorrect ✓<br><br>due to child's reaction time / distracted / child hears a different firework / sound cannot be heard clearly / wind may have an effect ✓<br><br>OR<br><br>Idea speed of sound varies ✓<br><br>Air is different temperature / density ✓ | 2<br>(AO3.2b)<br>(AO3.2a) | **DO NOT ACCEPT** faulty stopwatch<br><br>**ALLOW** different altitudes<br><br>**Examiner's Comments**<br><br>For this question, candidates needed to identify that the distance calculated depended on the time measured and the speed of sound. To gain full marks, candidates needed to identify the quantity that was not accurate and suggest a reason as to why this quantity may have been different. |
| | | | **Total** | **7** | |
| 8 | | | C ✓ | 1<br>(AO1.1) | **Examiner's Comments**<br><br>An important skill for candidates to develop is the ability to estimate quantities. |
| | | | **Total** | **1** | |
| 9 | | | B ✓ | 1<br>(AO1.1) | **Examiner's Comments**<br><br>This question tested the understanding of the definition of acceleration and the equation relating force, mass and acceleration. |
| | | | **Total** | **1** | |