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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **1** | Makes an attempt to substitute any of *n* = 1, 2, 3, 4, 5 or 6 into | **M1** | 1.1b | 5th  Complete proofs by exhaustion. |
| Successfully substitutes *n* = 1, 2, 3, 4, 5 **and** 6 into | **A1** | 1.1b |
| Draws the conclusion that as the statement is true for all numbers from 1 to 6 inclusive, it has been proved by exhaustion. | **B1** | 2.4 |
| (3 marks) | | | | |
| **Notes** | | | | |

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| 2 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Shows that | **M1** | 2.1 | 6th  Understand  small-angle approximations for sin, cos and tan (angle in radians). |
| Shows that | **M1** | 1.1b |
| Shows | **M1** | 2.1 |
| Recognises that | **A1** | 1.1b |
|  | **(4)** |  |  |
| **(b)** | When *θ* is small, | **A1** | 1.1b | 7th  Use small-angle approximations to solve problems. |
|  | **(1)** |  |  |
| (5 marks) | | | | |
| **Notes** | | | | |

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| 3 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Interprets the stone hitting the ground as when | **M1** | 3.4 | 8th  Use parametric equations in modelling in a variety of contexts. |
| Makes an attempt to use the quadratic formula to find *t*.  For example,is seen. | **M1** | 2.2a |
| Finds | **M1** | 1.1b |
| Deducesm. Accept awrt 24.6 | **A1** | 3.2a |
|  | **(4)** |  |  |
| **(b)** | Finds | **M1** | 2.2a | 8th  Use parametric equations in modelling in a variety of contexts. |
| Demonstrates an understanding that the greatest height will occur when. For example, | **M1** | 3.1a |
| Solves to find | **M1** | 1.1b |
| Makes an attempt to find the greatest height by substituting into  For example, | **M1 ft** | 3.2a |
| Finds *y* ==13.265… m. Accept awrt 13.3 m. | **A1 ft** | 1.1b |
|  | **(5)** |  |  |
| (9 marks) | | | | |
| Notes  **(b)** can also be found using. This is an acceptable method.  **(b)** Award ft marks for correct sketch using incorrect values from earlier in part **b**. | | | | |

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| 4 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Differentiatesto obtain | **M1** | 1.1b | 6th  Differentiate reciprocal and inverse trigonometric functions. |
| Writes | **A1** | 1.1b |
|  | **(2)** |  |  |
| **(b)** | Use the identityto write | **M1** | 2.2a | 6th  Differentiate reciprocal and inverse trigonometric functions. |
| Attempts to substituteandinto | **M1** | 2.2a |
| Correctly substitutes to findand states | **A1** | 1.1b |
|  | **(3)** |  |  |
| (5 marks) | | | | |
| **Notes** | | | | |

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| 5 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Clearly states that | **A1** | 1.1b | 5th  Integrate |
| Makes an attempt to integrate the remaining two terms. Raising a power by 1 would constitute an attempt. | **M1** | 1.1b |
| States the fully correct answer | **A1** | 1.1b |
|  | **(3)** |  |  |
| **(b)** | Makes an attempt to substitute the limits into the expression. For example,is seen. | **M1** | 1.1b | 5th  Integrate |
| Begins to simplify this expression. For example, is seen. | **M1** | 1.1b |
| States the fully correct answeror states , *n* = 6 and  Also acceptor equivalent. | **A1** | 1.1b |
|  | **(3)** |  |  |
| (6 marks) | | | | |
| Notes | | | | |

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| 6 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | States the range is  or | **B1** | 3.2b | 5th  Find the domain and range for a variety of familiar functions. |
|  | **(1)** |  |  |
| **(b)** | Recognises that  and | **M1** | 2.2a | 7th  Solve problems involving the modulus function in unfamiliar contexts. |
| Makes an attempt to solve both of these equations. | **M1** | 1.1b |
| Correctly states . Equivalent version is acceptable. | **A1** | 1.1b |
| Correctly states . Equivalent version is acceptable. | **A1** | 1.1b |
| Makes an attempt to substitute one equation into the other in an effort to solve for *k*. For example, and  is seen. | **M1 ft** | 2.2a |
| Correctly solves to find | **A1 ft** | 1.1b |
| States the correct range for *k*. | **B1** | 3.2b |
|  | **(7)** |  |  |
| (8 marks) | | | | |

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| Notes  **(b)** Award ft marks for a correct method using an incorrect answer from earlier in the question.  **Alternative Method**  Student draws the line with gradientpassing through the vertex and calculates that, so answer is  **M1**: States the *x*-coordinate of the vertex of the graph is 4  **M1**: States the *y*-coordinate of the vertex of the graph is −5  **M1**: Writes down the gradient ofor implies it later in the question.  **M1**: Attempts to use  with  and  **A1**: Finds o.e.  **B1**: States the correct range for *k*: |

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| 7 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
|  | Makes an attempt to set up a long division.  For example:  is seen.  The ‘0*x*’ being seen is not necessary to award the mark. | **M1** | 2.2a | 5th  Decompose algebraic fractions into partial fractions − two linear factors. |
| Long division completed so that a ‘1’ is seen in the quotient and a remainder of 25*x* + 32 is also seen. | **M1** | 1.1b |
| States | **M1** | 1.1b |
| Equates the various terms.  Equating the coefficients of *x*:  Equating constant terms: | **M1** | 2.2a |
| Multiplies one or both of the equations in an effort to equate one of the two variables. | **M1** | 1.1b |
| Finds | **A1** | 1.1b |
| Finds | **A1** | 1.1b |
| (7 marks) | | | | |
| Notes  **Alternative method**  Writes  as  States  Substitutes  to obtain:  Substitutes  to obtain:  Equating the coefficients of *x*2: | | | | |

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| 8 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | States the recurrence relation. Choice of variable is not important. or | **M1** | 3.1a | 5th  Work with sequences defined by simple recurrence relations. |
| Defines the first value. Accept either use of  or . or | **M1** | 3.1a |
|  | **(2)** |  |  |
| **(b)** | Makes an attempt to find the height, for example  is seen. | **M1** | 3.1a | 5th  Work with the *n*th term formula for geometric sequences. |
| States that the maximum height would be 13.445… cm. Accept awrt 13.4 | **A1** | 1.1b |
|  | **(2)** |  |  |
| **(c)** | Attempts to make use of the sum to infinity. For example,  or is seen. | **M1** | 3.1a | 6th  Use geometric sequences and series in context. |
| Understands that the ball travels upwards and then downwards, so multiplies by 2.  or  is seen. | **M1** | 3.1a |
| Recognises that when the ball is dropped, it initially only travels downwards. Either  or  is seen or implied. | **M1** | 3.1a |
| States a fully correct answer of cm. Accept awrt 453.3 cm. | **A1** | 1.1b |
|  | **(4)** |  |  |

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| **(d)** | ‘It is very unlikely that the ball will not bounce vertically’ or ‘This model assumes the ball will continue to bounce forever’. | **B1** | 3.5 | 6th  Understand convergent geometric series and the sum to infinity. |
|  | **(1)** |  |  |
| (9 marks) | | | | |
| Notes  **(c)** Award first method mark for an understanding that the sum to infinity formula is required.  Award second method mark for an understanding that the sum to infinity formula will need adjusting, i.e. the ball goes down and then up.  Award third method mark for an understanding that the ball only goes down initially as it is dropped. | | | | |

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| 9 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
|  | Uses the double-angle formulae to write: | **M1** | 2.2a | 6th  Use the  double-angle formulae for sin, cos and tan. |
| Uses the fact thatandto write: | **M1** | 1.1b |
| Simplifies this expression to | **M1** | 1.1b |
| Correctly solves to find | **A1** | 1.1b |
| (4 marks) | | | | |
| **Notes** | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **10** | Begins the proof by assuming the opposite is true.  ‘Assumption: there exists a rational numbersuch thatis the greatest positive rational number.’ | **B1** | 3.1 | 7th  Complete proofs using proof by contradiction. |
| Makes an attempt to consider a number that is clearly greater than:  ‘Consider the number, which must be greater than’ | **M1** | 2.2a |
| Simplifiesand concludes that this is a rational number.    By definition,is a rational number. | **M1** | 1.1b |
| Makes a valid conclusion.  This contradicts the assumption that there exists a greatest positive rational number, so we can conclude that there is not a greatest positive rational number. | **B1** | 2.4 |
| (4 marks) | | | | |
| **Notes** | | | | |

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| 11 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Writes  as | **M1** | 2.2a | 6th  Understand the binomial theorem for rational n. |
| Expands | **M1** | 1.1b |
| Simplifies:    Award mark even if *x2* term is not seen. | **M1** | 1.1b |
| Uses  to write *a* = 64. | **A1** | 1.1b |
| Uses to write *b* = –6. | **A1** | 1.1b |
|  | **(5)** |  |  |
| **(b)** | States expansion is valid for | **B1 ft** | 3.2b | 6th  Understand the conditions for validity of the binomial theorem for rational n. |
| Solves to state | **A1 ft** | 1.1b |
|  | **(2)** |  |  |
| **(c)** | Substitutes *a* = 64 and *b* = –6 into | **M1 ft** | 1.1b | 6th  Understand the binomial theorem for rational n. |
| Finds | **A1 ft** | 1.1b |
|  | **(2)** |  |  |
| (9 marks) | | | | |
| Notes  **(a)** Note *x*2 term is not necessary to answer part **a**, so is not required. Will be needed to answer part **c**.  **(b)** Award marks for a correct conclusion using incorrect values of *a* and *b* from part **a**.  **(c)** Award marks for a correct answer using incorrect values of *a* and *b* from part **a**. | | | | |

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| 12 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
|  | Findsvia *M* | **M1** | 3.1a | 6th  Solve geometric problems using vectors in 3 dimensions. |
| Findsvia *N* | **M1** | 3.1a |
| Finds | **M1** | 3.1a |
| Finds | **M1** | 3.1a |
| Equates the two ways of moving from *O* to *P*. | **M1** | 2.2a |
| Equates coefficients of *a:* | **M1** | 2.2a |
| Equates coefficients of *b*. OR equates coefficients of *c*. | **M1** | 1.1b |
| Solves to find | **A1** | 1.1b |
| Concludes that at this value the lines intersect. | **B1** | 2.1 |
| Concludes that the lines must bisect one another as  and | **B1** | 2.1 |
| (10 marks) | | | | |
| Notes | | | | |

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| 13 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | States | **M1** | 3.3 | 8th  Solve differential equations in a range of contexts. |
| Separates the variables | **M1** | 2.2a |
| Finds | **A1** | 1.1b |
| Shows clearly progression to state  For example, is seen. May also explain the  whereis a constant. | **A1** | 2.1 |
|  | **(4)** |  |  |
| **(b)** | States | **M1** | 3.3 | 8th  Solve differential equations in a range of contexts. |
| Simplifies the expression by cancellingand then taking the natural log of both sides | **M1** | 2.2a |
| States that | **A1** | 1.1b |
|  | **(3)** |  |  |
| **(c)** | States | **M1** | 3.3 | 8th  Solve differential equations in a range of contexts. |
| Simplifies the expression by cancelling  and then taking the natural log of both sides | **M1** | 2.2a |
| Finds *t* = 18.613… years. Accept 18.6 years. | **A1** | 1.1b |
|  | **(3)** |  |  |
| (10 marks) | | | | |
| Notes | | | | |

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| 14 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | States that the local maximum occurs when | **B1** | 3.1a | 7th  Use numerical methods to solve problems in context. |
| Makes an attempt to differentiate p(*t*) | **M1** | 2.2a |
| Correctly finds | **A1** | 1.1b |
| Finds  and | **M1** | 1.1b |
| Change of sign and continuous function in the interval  Therefore the gradient goes from positive to negative and so the function has reached a maximum. | **A1** | 2.4 |
|  | **(5)** |  |  |
| **(b)** | States that the local minimum occurs when | **B1** | 3.1a | 7th  Use numerical methods to solve problems in context. |
| Makes an attempt to differentiate | **M1** | 2.2a |
| Correctly finds | **A1** | 1.1b |
| Findsand | **M1** | 1.1b |
| Attempts to find | **M1** | 1.1b |
| Finds | **A1** | 1.1b |
|  | **(6)** |  |  |
| (11 marks) | | | | |
| Notes  **(a)** Minimum required is that answer states there is a sign change in the interval and that this implies a root in the given interval. | | | | |