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| 1 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
|  | Begins the proof by assuming the opposite is true.  ‘Assumption: there exists a product of two odd numbers that is even.’ | **B1** | 3.1 | 7th  Complete proofs using proof by contradiction. |
| Defines two odd numbers. Can choose any two different variables.  ‘Let 2*m +* 1 and 2*n +* 1 be our two odd numbers.’ | **B1** | 2.2a |
| Successfully multiplies the two odd numbers together: | **M1** | 1.1b |
| Factors the expression and concludes that this number must be odd.    is even, so  must be odd. | **M1** | 1.1b |
| Makes a valid conclusion.  This contradicts the assumption that the product of two odd numbers is even, therefore the product of two odd numbers is odd. | **B1** | 2.4 |
| (5 marks) | | | | |
| Notes  Alternative method  Assume the opposite is true: there exists a product of two odd numbers that is even. (**B1)**  If the product is even then 2 is a factor. (**B1)**  So 2 is a factor of at least one of the two numbers. (**M1)**  So at least one of the two numbers is even. (**M1)**  This contradicts the statement that both numbers are odd. (**B1)** | | | | |

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| 2 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Writes out the first *n* terms of the arithmetic sequence in both ascending and descending form | **M1** | 2.4 | 5th  Understand the proof of the *Sn* formula for arithmetic series. |
| Attempts to add these two sequences | **M1** | 2.4 |
| States | **A1** | 1.1b |
|  | **(3)** |  |  |
| **(b)** | Makes an attempt to find the sum. For example,  is seen. | **M1** | 2.2a | 4th  Understand simple arithmetic series. |
| States correct final answer. *S* = 40 000 | **A1** | 1.1b |
|  | **(2)** |  |  |
| (5 marks) | | | | |
| Notes  **(a)** Do not award full marks for an incomplete proof.  **(a)** Do award second method mark if student indicates that (2*a + (n* − 1)*d* appears *n* times. | | | | |

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| 3 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
|  | Makes an attempt to differentiate *y* = ln 3*x* using the chain rule, or otherwise. | **M1** | 2.2a | 6th  Differentiate sums and differences of functions involving trigonometric, logarithmic and exponential functions. |
| Differentiatesto obtain | **A1** | 1.1b |
| Evaluates at | **A1** | 1.1b |
| Evaluates at *x* = 1 | **M1** | 1.1b |
| Attempts to substitute values into  For example,  is seen. | **M1 ft** | 2.2a |
| Shows logical progression to simplify algebra, arriving at: | **A1** | 2.4 |
| (6 marks) | | | | |
| Notes  Award ft marks for a correct attempt to substitute into the formula using incorrect values. | | | | |

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| 4 | Scheme | | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | Statesand | | **M1** | 1.1b | 6th  Convert between parametric equations and cartesian forms using trigonometry. |
| Recognises that the identitycan be used to find the cartesian equation. | | **M1** | 2.2a |
| Makes the substitution to find | | **A1** | 1.1b |
|  | | **(3)** |  |  |
| **(b)** | States or implies that the curve is a circle with centre (−4, 3) and radius 7 | | **M1 ft** | 2.2a | 6th  Sketch graphs of parametric functions. |
| Substitutesto find *x* = −11 and *y* = 3 (−11, 3)  Substitutes to find *x* ≈ 2.06 and *y* = 6.5 (2.06, 6.5)  Could also substitute *t* = 0 to find *x* = −4 and *y* = 10 (−4, 10) | | **M1 ft** | 1.1b |
| **Figure 1** | Draws fully correct curve. | **A1 ft** | 1.1b |
|  | | **(3)** |  |  |
| **(c)** | Makes an attempt to find the length of the curve by recognising that the length is part of the circumference. Must at least attempt to find the circumference to award method mark. | | **M1 ft** | 1.1b | 6th  Sketch graphs of parametric functions. |
| Uses the fact that the arc isof the circumference to write  arc length = | | **A1 ft** | 1.1b |
|  | | **(2)** |  |  |
| (8 marks) | | | | | |
| Notes  **(b)** Award ft marks for correct sketch using incorrect values from part **a**.  **(c)** Award ft marks for correct answer using incorrect values from part **a**.  **(c)** Alternative method: use, withand. Award one mark for the attempt and one for the correct answer. | | | | | |

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| 5 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | States | **M1** | 2.2a | 5th  Find the magnitude of a vector in 3 dimensions. |
| Makes an attempt to solve the equation.  For example,is seen. | **M1** | 1.1b |
| States *k* = 2 and *k* = 18 | **A1** | 1.1b |
|  | **(3)** |  |  |
| **(b)** | Finds the vector | **M1 ft** | 1.1b | 5th  Find the magnitude of a vector in 3 dimensions. |
| Finds | **M1 ft** | 1.1b |
| States the unit vector | **A1 ft** | 1.1b |
|  | **(3)** |  |  |
| (6 marks) | | | | |
| Notes  **(b)** Award ft marks for a correct answer topart **b** using their incorrect answer frompart **a.** | | | | |

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| 6 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
|  | Makes an attempt to find  Writingor writingconstitutes an attempt. | **M1** | 2.2a | 6th  Integrate using the reverse chain rule. |
| Correctly states | **A1** | 2.2a |
| Makes an attempt to substitute the limits *x* = ln *b* and *x* = ln 2 into  For example,and is seen. | **M1 ft** | 1.1b |
| Uses laws of logarithms to begin to simplify the expression. Eitheror is seen. | **M1 ft** | 2.2a |
| Correctly states the two answers as and | **A1 ft** | 1.1b |
| States that | **M1 ft** | 2.2a |
| Makes an attempt to solve this equation.  For example,is seen. | **M1 ft** | 1.1b |
| Correctly states the final answer *b* = 7 | **A1 ft** | 1.1b |
| (8 marks) | | | | |
| Notes  Student does not need to state ‘+C’ in an answer unless it is the final answer to an indefinite integral.  Award ft marks for a correct answer using an incorrect initial answer. | | | | |

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| 7 | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **(a)** | States that | **A1** | 1.1b | 5th  Work with sequences defined by simple recurrence relations. |
| Attempts to substitute  into .  and simplifies to find | **A1** | 1.1b |
|  | **(2)** |  |  |
| **(b)** | States  or | **M1** | 2.2a | 5th  Work with sequences defined by simple recurrence relations. |
| Factorises to get | **M1** | 1.1b |
| States *p* = 5. May also state that , but mark can be awarded without that being seen. | **A1** | 1.1b |
|  | **(3)** |  |  |
| **(c)** |  | **A1 ft** | 1.1b | 5th  Work with sequences defined by simple recurrence relations. |
|  | **(1)** |  |  |
| (6 marks) | | | | |
| Notes  **(c)** Award mark for a correct answer using their value of *p* from part **b**. | | | | |

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| **8** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
|  | Correctly factorises the denominator of the left-hand fraction: | **M1** | 2.2a | 4th  Add, subtract, multiply and divide algebraic fractions. |
| Multiplies the right-hand fraction by  For example:  is seen. | **M1** | 1.1b |
| Makes an attempt to distribute the numerator of the right-hand fraction.  For example:  is seen. | **M1** | 1.1b |
| Fully simplified answer is seen.  Accept either  or | **A1** | 1.1b |
| **(4 marks)** | | | | |
| **Notes** | | | | |

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| **9** | **Scheme** | | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **(a)** | **Figure 2**  \\192.168.0.251\Pearson\A Level Maths\WIP files\Unit tests\Pure 2\Artwork\02. Files from YPS\alevel_ut_p2_u3_markscheme_aw2.png | Clear attempt to reflect the negative part of the original graph in the *x*-axis. | **M1** | 2.2a | 7th  Sketch the graphs of the modulus function of unfamiliar non-linear functions. |
| Labels all three points correctly. | **A1** | 1.1b |
| Fully correct graph. | **A1** | 1.1b |
|  | | **(3)** |  |  |
| **(b)** | **Figure 3**  \\192.168.0.251\Pearson\A Level Maths\WIP files\Unit tests\Pure 2\Artwork\02. Files from YPS\alevel_ut_p2_u3_markscheme_aw3.png | Clear attempt to reflect the positive *x* part of the original graph in the *y*-axis. | **M1** | 2.2a | 7th  Sketch the graphs of the modulus function of unfamiliar non-linear functions. |
| Labels all three points correctly. | **A1** | 1.1b |
| Fully correct graph. | **A1** | 1.1b |
|  | | **(3)** |  |  |
| **(c)** | **Figure 4** | Clear attempt to move the graph to the left 3 spaces. | **M1** | 2.2a | 6th  Combine two or more transformations, including modulus graphs. |
| Clear attempt to stretch the graph vertically by a factor of 2. | **M1** | 2.2a |
| Fully correct graph. | **A1** | 1.1b |
|  | | **(3)** |  |  |
| **(9 marks)** | | | | | |
| **Notes** | | | | | |

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| **10** | **Scheme** | | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **(a)** | **C:\Users\Haremi_0228\Desktop\Images\alevel_ut_p2_u9_test_aw2.png** | Attempts to sketch both and | **M1** | 3.1a | 5th  Understand the concept of roots of equations. |
| States thatmeetsin just one place, therefore has just one root  has just one root | | **A1** | 2.4 |
|  | | **(2)** |  |  |
| **(b)** | Makes an attempt to rearrange the equation. For example, | | **M1** | 1.1b | 5th  Understand the concept of roots of equations. |
| Shows logical progression to state  For example,is seen. | | **A1** | 1.1b |
|  | | **(2)** |  |  |
| **(c)** | Attempts to use iterative procedure to find subsequent values. | | **M1** | 1.1b | 6th  Solve equations approximately using the method of iteration. |
| Correctly finds: | | **A1** | 1.1b |
|  | | **(2)** |  |  |

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| **(d)** | Correctly finds | **A1** | 2.2a | 6th  Solve equations approximately using the Newton–Raphson method. |
| Findsand | **M1** | 1.1b |
| Attempts to find: | **M1** | 1.1b |
| Finds | **A1** | 1.1b |
|  | **(4)** |  |  |
| **(10 marks)** | | | | |
| **Notes**  **(a)** Uses their graphing calculator to sketch(**M1**)  **C:\Users\Haremi_0228\Desktop\Images\alevel_ut_p2_u9_test_aw3.png**  States that as g(*x*) only intersects the *x*-axis in one place, there is only one solution. (**A1**)  **(c)** Award M1 if finds at least one correct answer. | | | | |

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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. |
| Uses the binomial expansion to write: | **M1** | 2.2a |
| Simplifies to obtain: | **M1** | 1.1b |
| Writes the correct final answer: … | **A1 ft** | 1.1b |
|  | **(4)** |  |  |
| **(b)** | Either states or states | **B1** | 3.2b | 6th  Understand the conditions for validity of the binomial theorem for rational n. |
|  | **(1)** |  |  |
| **(c)** | Makes an attempt to substitute  into  For example | **M1** | 1.1b | 6th  Understand the binomial theorem for rational n. |
| Continues to simplify the expression:  And states the correct final answer: | **A1** | 1.1b |
|  | **(2)** |  |  |

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| **(d)** | Substitutes  into  Obtains: | **M1 ft** | 2.2a | 6th  Understand the binomial theorem for rational n. |
| States that | **M1 ft** | 1.1b |
| Deduces that | **A1 ft** | 1.1b |
|  | **(3)** |  |
| **(10 marks)** | | | | |
| **Notes**  **(a)** Award 3 marks if a student has used an incorrect expansion but worked out all the other steps correctly.  **(d)** Award all three marks if a student provided an incorrect answer in part **a**, but accurately works out an approximation for root 2 consistent with this incorrect answer. | | | | |

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| **12** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **(a)** | Correctly substitutes *x =* 1.5 intoand obtains 2.2323… | **A1** | 1.1b | 5th  Understand and use the trapezium rule. |
|  | **(1)** |  |  |
| **(b)** | States or implies formula for the trapezium rule | **M1** | 2.2a | 5th  Understand and use the trapezium rule. |
| Makes an attempt to substitute into the formula | **M1** | 1.1b |
| States correct final answer 1.610 (4 s.f.) | **A1** | 1.1b |
|  | **(3)** |  |  |

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| **(c)** | Recognises the need to make a substitution.  **Method 1**  is seen. | Recognises the need to make a substitution.  **Method 2**  is seen. | **M1** | 2.2a | 6th  Integrate functions by substitution. |
| Correctly statesand finds new limits  and | States and finds  and finds new limits and | **M1** | 1.1b |
| Correctly transforms the integralinto | Correctly transforms the integral into | **M1** | 2.2a |
| Correctly finds the integral | Correctly finds the integral | **M1** | 1.1b |
| Makes an attempt to substitute the limits | Makes an attempt to substitute the limits | **M1** | 1.1b |
| Correctly finds answer | Correctly finds answer | **A1** | 1.1b |
|  | | **(6)** |  |  |
| **(d)** | Using more strips would improve the accuracy of the answer. | | **B1** | 3.5c | 5th  Understand and use the trapezium rule. |
|  | | **(1)** |  |  |
| **(11 marks)** | | | | | |
| **Notes**  **(c)** Either method is acceptable. | | | | | |

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| **13** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **(a)** | States:    Or: | **M1** | 1.1b | 6th  Understand how to use identities  to rewrite  acos*x* + bsin*x*. |
| Deduces that: | **M1** | 1.1b |
| States that  Use of might be seen, but is not necessary to award the mark. | **A1** | 1.1b |
| Finds that  might be seen, but is not necessary to award the mark. | **A1** | 1.1b |
|  | **(4)** |  |  |
| **(b)** | Uses the maths from part **a** to deduce that | **A1** | 3.4 | 7th  Solve problems involving  acos*x* + bsin*x.* |
| Recognises that the maximum temperature occurs when | **M1** | 3.4 |
| Solves this equation to find | **M1** | 1.1b |
| Finds *x* = 15.81 hours | **A1** | 1.1b |
|  | **(4)** |  |  |

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| **(c)** | Deduces that | **M1** | 3.4 | 8th  Use trigonometric functions and identities to solve problems in a range of unfamiliar contexts. |
| Begins to solve the equation. For example,  is seen. | **M1** | 1.1b |
| States that Further values may be seen, but are not necessary in order to award the mark. | **M1** | 1.1b |
| Finds that *x* = 2.65 hours, 10.13 hours, 21.50 hours | **A1** | 1.1b |
|  | **(4)** |  |  |
| **(12 marks)** | | | | |
| **Notes** | | | | |