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**Pearson Edexcel GCE in Mathematics (9MA0)**

**Pure Mathematics Practice Questions**

**Mark Scheme**

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**General Marking Guidance** (applied to exam questions)

* All candidates must receive the same treatment.  Examiners must mark the first candidate in exactly the same way as they mark the last.
* Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
* Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
* There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
* All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme.  Examiners should also be prepared to award zero marks if the candidate’s response is not worthy of credit according to the mark scheme.
* Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
* When examiners are in doubt regarding the application of the mark scheme to a candidate’s response, the team leader must be consulted.
* Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

**Guidance on the use of codes within this mark scheme:**

* **M** – Mark is for method
* **Mdep** – Mark is dependent on one or more M marks and is for method
* **A** – Mark is dependent on M or m marks and is for accuracy
* **B** – Mark is independent of M or m marks and is for method and accuracy
* **E** – Mark is for explanation
* **ft** – Follow through from previous incorrect result
* **cao** – Correct answer only
* **cso** – Correct solution only
* **awfw** – Anything which falls within
* **awrt** – Anything which rounds to
* **\*** – Answer given
* **SC** – Special case
* **o.e.** – Or equivalent
* **A2, 1** – 2 or 1 (or 0) accuracy marks
* **sf** – Significant figure(s)
* **dp** – Decimal place(s)

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **1**  | Let   | M1 | 2.1 |
| Use  to form an equation in *x* and *y* | M1 | 1.1b |
|  | A1 | 1.1b |
|  (Hence *k* = 3) | A1 | 2.1 |
| **(4 marks)** |
| **Notes**M1: Finds *x* and *y* in terms of another variable.M1: Uses  or equivalent to form an equation in terms of *x* and *y* only.A1: Correct equation in terms of *x* and *y*.A1: Correct equation in the required form. |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **2(i)** |  so  for all *x* but when ,  so  for all values of *x* \* | M1M1A1A1\* | 2.12.12.2a2.4 |
|  |  | **(4)** |  |
| **(ii)** | Considers each combination:

|  |  |  |
| --- | --- | --- |
| *x* | *y* | *xy* |
| 1 | ±5 | ±5 |
| 2 | ±4 | ±8 |
| 3 | ±3 | ±9 |
| 4 | ±2 | ±8 |
| 5 | ±1 | ±5 |
| 6 | 0 | 0 |

All answers correct and concludes that all products are between 10 and 10. | M1A1\* | 2.12.2a |
|  |  | **(2)** |  |
| **(6 marks)** |
| **Notes** (i)M1 Attempts to multiply out the lhs, collect non-trigonometric terms on one side and attempts to complete the squareM1 Uses double angle formulae to write the trigonometric expression on the rhs as a single trigonometric functionA1 Deduces the lhs must be greater than or equal to 1A1\* Considers the case when the lhs equals one and explains that the rhs is not equal to one so the original statement is true for all values of *x*(ii)M1 Attempts to calculate at least 6 different valid productsA1\* All calculations shown and concludes that all products are between 10 and 10 |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **3 (a)** | Selects two irrational numbers that give a rational sum.For example,  and  | M1 | 1.1b |
| which isrational | A1 | 2.4 |
|  | **(2)** |  |
| **(b)** |  ‘Assumption: There exists a rational number *a* and an irrational number *b* such that *a* + *b* is rational.’ | B1 | 2.1 |
| As *a* and *a* + *b* are rational then they can be expressed in the form and  where *m*, *n*, *p*, *q* ∈  | M1 | 1.1b |
|  | A1 | 2.1 |
| Explain that  is rational which contradicts the assumption *b* is an irrational number. Therefore the sum of a rational number and an irrational number is irrational. | A1 | 2.4 |
|  | **(4)** |  |
| **(6 marks)** |

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| **Notes**(a) M1: Selects two irrational numbers that give a rational sum.A1: Finds a correct sum and makes a valid conclusion.(b) B1: Begins the proof by assuming the opposite is true. M1: Sets up the proof by defining the different rational and irrational numbers.  The choice of variables does not matter. A1: Completes the proof with correct algeba. A1: Makes a valid conclusion*.* c.s.o. |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **4(a)** |  | M1M1A1 | 1.1b2.11.1b |
|  |  | **(3)** |  |
| **(b)** |  | M1 | 2.1 |
|  |   |  |  |
|  |   | A1ft | 2.2a |
|  |  | **(2)** |  |
| **(5 marks)** |

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| **Notes**(a) M1: Uses one of the small angle approximations M1: Uses both approximations and an attempt to remove bracketsA1: Correct answer only(b) M1: Attempting to use the double angle formula, accept sign slips A1ft: but ft on their answer to (a)Alts for (b)  Or  |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **5(a)** | Attempts gradient  and gradient  | M1 | 3.1a |
| Achieves gradient  and gradient  | A1 | 1.1b |
| Explains that as (gradient ) 🞩( gradient *QR*) then angle *PQR* = 90  | A1 | 2.4 |
|  |  | **(3)** |  |
| **(b)** |  Deduces that centre of *C* is   | B1 | 2.2a |
| Finds radius of circle using distance from any of *P*, *Q* or *R* and  E.g. to is 5 units | M1 | 1.1b |
| Writes an equation of *C*. E.g.   | A1 | 2.1 |
|  |  | **(3)** |  |
| **(6 marks)** |

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| **Notes**(a)M1: Attempts to find the gradients of both *PQ* and *QR*A1: Achieves correct gradients for both *PQ* and *QR*A1: Correct explains that since the product of gradients is -1 or equivalent statement, that angle *PQR* = 90 (a) **Alternative: Using Pythagoras:**M1: Attempts to find lengths of *PQ, QR* and *PR*A1: Correctly finds *PQ* = √20 , *QR* = √80 , PR = 10 oeA1: Correct explains that since *PQ*² + *QR*² = *PR*² or equivalent, that angle *PQR* = 90 (b)B1: Deduces that centre of *C* is  Can be implied in equation of circle M1: Finds radius of circle using distance from any of *P*, *Q* or *R* to A1: Correct equation  |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **6** | Sets up the contradiction:Assume that there exists a rational *x* and an irrational *y* such that  is rational | M1 | 2.1 |
| As  and *x* are rational, so  =  and *x* = Y = *x* ÷ =  ÷  |  A1 | 3.1a |
|   | dM1 | 1.1b |
| Explains that this is a contradiction so therefore  is irrational | A1 cso | 2.4 |
| **(4 marks)** |
| **Notes**M1: sets up the contradiction A1: uses algebra to get a correct expression in terms of *y* dM1: states *y* is rational with reasonA1: for completing the proof by contradiction, with no errors or omissions  |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **7(a)** |  \* | M1A1\* | 1.1b2.1 |
|  |  | **(2)** |  |
| **(b)** |  | B1B1 | 2.2a2.2a |
|  |  | **(2)** |  |
| **(c)** | Maximum gradient:Minimum gradient between  and One of or  | M1A1dM1M1A1A1 | 3.1a1.1b2.12.2a1.1b2.5 |
|  |  | **(6)** |  |
| **(d)(i)** |  | B1 | 2.2a |
| **(ii)** |  | B1 | 2.2a |
|  |  | **(2)** |  |
| **(12 marks)** |

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| **Alt(a)** |  | M1A1\* | 1.1b2.1 |
|  |  | **(2)** |  |
| **Notes** (a)M1 Substitutes ,  into the given equation and reaches . In the alternative method they rearrange both parametric equations to make sin *t* and cos *t* the subjects.A1\* Uses  and reaches the given answer with no errors. They must either state the identity or show  being replaced with 1(b)B1 B1 (c)M1 Substitutes into the equation of the circle and attempts to collect terms on one side of the equation to produce a 3TQ in *x*A1  oedM1 Uses the discriminant condition to find the maximum gradient. Sets and proceeds to finding a value for *m*. It is dependent on the previous method mark.M1 Deduces that the minimum gradient will be when and proceeds to calculate the gradient between the coordinate of *P* at that point and . A1 One of  or A1  (including correct use of set notation)(d)B1  cao (deduces the largest possible area requires using the maximum *x* coordinate for *P*)B1  cao (deduces the smallest possible area requires using the minimum *x* coordinate for *P*) |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **8(a)** | Valid attempt at one possible  Eg.  **or**   | M1 | 3.1a |
| Either  = 6**i +**4**j +**9**k** or4**i +**3**k**  | A1 | 1.1b |
| Both (6 , 4 , 9 ) **and** ( 4 , 0 , 3) | A1 | 2.1 |
|  |  | **(3)** |  |
| **(b)** |   5 | M1A1 | 1.1b1.1b |
|  |  | **(2)** |  |
| **(5 marks)** |
| **Notes**M1: A complete method to find one possible value for position vector for *C* (allow a slip in calculation). A1: One correct position for *C* correctly found (Accept a position vector here)A1: Both correct coordinates of *C*1.

M1: Calculating the magnitude of their  for one of the coordinates.A1: Selecting the correct length, OC = 5. |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **9** | Attempts  | M1 | 3.1a |
|  =  | A1 | 1.1b |
|   o.e. for e.g.  | M1 | 2.1 |
| States that is a multiple of 3 **AND** since “5” or “1” is not divisible by 3 therefore result proven | A1 | 2.4 |
| **(4 marks)** |
| **Notes**M1 A1 AlternativesEtc.2nd M1: Attempt to factorise 3 and leave an appropriate remainderFinal A1: CSO. Scored for a correct explanation following correct work |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **10(a)** | Attempts to use the ''200'' and the ''2*x*'' to find the width of the rectangle | M1 | 3.1b |
| Correct width  | A1 | 1.1b |
|  | M1 | 1.1b |
|  | A1(\*) | 2.1 |
|  |  | **(4)** |  |
| **(b)** |  | M1 | 3.1a |
|  | A1 | 1.1b |
| set to zero, solve for *x*  and sub in to find *A* = | M1 | 2.1 |
| {*Amax*=} 3025 {m2} | A1 | 1.1b |
|  | Their “3025”÷ 120 Therefore 25 lambs  | A1ft | 1.1b |
|  |  | **(5)** |  |
| **(c)** |  | M1 | 1.1a |
|  |  | A1 | 2.4 |
|  |  | **(2)** |  |
| **(11 marks)** |

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| **Notes*****Alternatives for 10b.***Completing the square:M1 A1 M1 *x* = their “17.5” and substitutes to find *A*A1 {*Amax*=} 3025 {m2}A1ft as main scheme***Alternatives for 10c.***Gradient either sideM1 evaluates at values either side of their *x*A1 States LHS is positive and RHS is positive hence result is a maximum Note that their *x* must have been correct for A1Evaluates A either sideM1 evaluates A at values either side of their *x*A1 States that both LHS A and RHS A are below 3025 hence result is a maximum Note that their *x* must have been correct for A1 |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **11(a)** |  | M1 | 1.1b |
| Uses    | M1 | 1.1b |
| Solves their equations to find *k*  | M1 | 3.1a |
|   | A1 | 1.1b |
|  | **(4)** |  |
| **(b)** | Uses their *k* to find values for ‘*a*’ and ‘*d* ’ | M1 | 3.1a |
|   | M1 | 1.1b |
| Sum of first 20 terms = 1620 | A1 | 1.1b |
|  | **(3)** |  |
| **(c)** |   | M1 | 2.1 |
| Creating and solving the resultant 3TQ   | M1 | 1.1b |
| *N* = 45 | A1 | 1.1b |
|  | **(3)** |  |
| **(10 marks)** |
| **Notes****(a)**M1: Uses the first two terms to find an expression for ‘*d* ’ in terms of *k*. M1: Uses the *n*th term formula with  and the given value of to form an equation  linking ‘*d* ’ and *k*.M1: A complete method to find *k*. (They must have all the necessary information.)A1:  CAO **(b)**M1: Realises the need to use their value of *k* to find values for ‘*a*’ and ‘*d* ’M1: Substitutes *n* = 20 and their values for ‘*a*’ and ‘*d* ’ into a correct formula.A1:  **(c)**M1: Uses their ‘*a*’ and ‘*d* ’in a correct formula.M1: Forms and solves a 3TQ to find *N*A1: *N* = 45 (only) |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **12(a)** | You cannot exceed 100% UVB protection | B1 | 2.4 |
|  |  | **(1)** |  |
| **(b)(i)** | Overall method: form and solve simultaneous equations and apply a log law  \* | M1M1A1M1A1\* | 3.31.1b2.2a1.1b2.1 |
| **(b)(ii)** | awrt 15.0 | B1 | 1.1b |
|  |  | **(6)** |  |
| **(c)** | awrt 86 (%) As this is **far/not close (oe)** from 50% this is **not suitable** | M1A1 | 3.43.5a |
|  |  | **(2)** |  |

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| **(d)** |  |  |  |
|  | , All three values correct (2sf) and justified comment | M1A1 | 3.43.5a |
|  |  | **(2)** |  |
| **(11 marks)** |
| (a)B1 You cannot exceed 100% UVB protection/ 100% is the upper limit/ 100 is an asymptote(b)(i)M1 An overall method to set up two simultaneous equations, solve and use of a log lawM1 Forms two simultaneous equations and solves to achieve an equation of the form  oeA1 M1 Applies log laws and attempts to make  or  the subjectA1\* Rearranges to reach the given answer with no errors(ii)B1 awrt 15.0 allow 15(c)M1 Substitutes into their model to find a value for *P.*A1 awrt 86 (%) and concludes that as the value is **not very close** to 50 then it is **not suitable**(d)M1 Substitutes into the model A1 All three correct values correct to 2sf and accept any justified comment. |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **13(a)** |  | B1 | 3.4 |
|  | **(1)** |  |
|  **(b)(i)** |  | M1 | 3.1a |
|  | A1 | 1.1b |
|  | A1\* | 2.1 |
|  | **(3)** |  |
| **(b)(ii)** |  | B1 | 1.1b |
|  | M1 | 3.4 |
| hectares | A1 | 2.5 |
|  | **(3)** |  |
| **(c)** |  | M1 | 1.1b |
| Sign change,  is continuous, hence lies in the interval  | A1 | 2.4 |
|  | **(2)** |  |
| **(d)** |  | M1 | 1.1b |
|  years | A1 | 2.2a |
|  |  | **(2)** |  |
| **(11 marks)** |

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| **Notes**(a) B1: 150(b) (i) M1: Attempts to differentiate and sets their . A1: Correct differentiation. A1: fully correct proof leading to the given equation.(b) (ii) B1: Solves the 3TQ to find . Ignore second presence of second solution. M1: selects the positive value of  and substitutes into . A1: a.w.r.t. 164(c) M1: Substitutes  and into . A1: Correct values for rounded or truncated to 2 significant figures and correct conclusion.(d) M1: Substitutes 15 into  A1: 15.122 (years) |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **14(a)(i)** |    *OB* = 905.69…. = 906 m (to nearest metre)     | M1A1A1ft | 3.1a1.1b2.2b |
|  |  | **(3)** |  |
| **(a)(ii)**  | E.g. * may not necessarily travel in a straight line as wind speed and/or wind direction not taken into account. may not fly level due to turbulence or air pressure
 | B1 | 3.5a |
|  |  | **(1)** |  |
| **(b)** |   o.e.     Bearing = 180 + '21.6' ( ft an acute angle) = 202° ( to nearest degree) | M1A1A1ft | 3.1a1.1b2.1 |
|  |  | **(3)** |  |
| **(7 marks)** |
| **Notes**(a) (i) M1: Uses the correct cosine rule with their angleA1: awrt 906A1: awrt 41 sec(a)(ii) B1: for an acceptable reason referring to either not flying in a straight line or at a level height.(b) M1: Attempting to apply sin rule to their triangle to find an angleA1: awrt 21.6, may be implied by their final answer ( ignore any other angles)A1ft: Calculating a bearing 180 + their acute angle  |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **15(a)** | *r* = 3 | B1 | 2.2a |
| Sets *t* = 3 (or *t* = their *r*), *m* = 74 to find *p*, then sets *t* = 0, *m* = 29 to find *q* | M1 | 3.1a |
| *m* = 74 – 5(*t* – 3)2  | A1 | 3.3 |
|  | **(3)** |  |
| **(b)** | substitute *t* = 1.75 into their *m* = 74 – 5(*t* – 3)2, *m* = ... | M1 | 3.4 |
| 66 or awrt 66.2 | A1 | 1.1b |
|  | **(2)** |  |
| **(c)** | Gives a suitable limitation. For example* the mark Nisha achieves becomes negative after around 7 hours revision
* Nisha's marks go down if she revises for longer than 3 hours
 | B1 | 3.5b |
|  |  | **(1)** |  |
| **(6 marks)** |
| **Notes**(a) B1: Deduces that *r* = 3 M1: A complete method to find *p* and *q*A1: Fully correct equation for model(b) M1: substitutes 1.75 into their equation to find a value for *m*A1: correct answer (c)B1: Gives a suitable limitation |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **16(a)(i)** | *A* = 540 | B1 | 3.4 |
| **(a)(ii)** |  leading to *k*=…  = 1.07884 | M1 | 3.4 |
| A1 | 1.1b |
|  |  | **(3)** |  |
|  **(b)** | = £1 067 000 | M1 | 3.4 |
| A1 | 1.1b |
|  |  | **(2)** |  |
| **(c)** | Price of land does not always increase at the same rate each year.Does not take into account outside factors such as recession, growth of economy etc | B1 | 3.5b |
|  |  | **(1)** |  |
| **(d)** |   leading to   | M1 | 3.1b |
|  |    | A1 | 1.1b |
|  |   | M1 | 1.1b |
|  |  *t* = 29.7 **Year 1961**  | A1 | 3.2a |
|  |  | **(4)** |  |
| **(10 marks)** |

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| **Notes**(a)(i) B1: Deduces that *A* = 540(a)(ii)M1:Uses the model to attempt to find a value for *k*.A1: Finds *k* = 1.07884 to 5 dp (b) M1: Uses their model to find the value of *P* when t = 100A1: Finds *P* = £1 067 000 to nearest £1000(c)B1: Deduces correct limitation of the modeleg price does not always increase at the same rate each year or does not take into account external factors such as recession, growth of economy etc(d)M1: Equates the two models and arrives at an expression of the form A1: Achieves correct expression in the form  eg  M1: Correct use of logs to find a value for *t* A1: Finds correct value of *t* and hence deduces the year is 1961. |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **17(a)** |   | B1 | 3.1a |
| {+*c*} *A*, *B* ≠ 0 | M1 | 1.1b |
|  {+*c*} (oe)  | A1 | 1.1b |
| {*t* = 0, *h* = 0} 0 = –2(1) + *c*, *c* = ...  | M1 | 3.4 |
| (oe) | A1 | 1.1b |
| *h =*  | A1 | 3.3 |
|  | **(6)** |  |
| **(b)** | *h* = = … | M1 | 3.4 |
| 4.35 m or 435 cm  | A1 | 3.2a |
|  | **(2)** |  |
| **(c)** | sets cos 4*T* = –1, so 4*T* = π  | M1 | 3.1b |
| *T* = awrt 47.1 seconds | A1 | 1.1b |
|  |  | **(2)** |  |
| **(10 marks)** |

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| **Notes**(a) B1: separates variables correctlyM1: both sides integrated to correct formA1: correct integral, with or without +*c*M1: substitutes *t* = 0, *h* = 0 to find a value for *c*A1: a correct equation linking *h* and *t*A1: correct and in the form *h* = f(*t*)(b)M1: puts cos 4*t* = –1 into their equation to give *h* = ...A1: must include units(c)M1: for identifying 4*T* = πA1: awrt 47.1 |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **18(a)** |  | M1 | 1.1b |
| States  | A1 | 1.1b |
|  | A1 | 1.1b |
|  | **(3)** |  |
| **(b)** |   | B1ft | 3.4 |
|  | **(1)** |  |
| **(c)** |  | M1 | 3.1b |
|   | M1 | 1.1b |
| 16:06 or 4:06 pm  | A1 | 3.2b |
|  | **(3)** |  |
| **(d)** |  | M1 | 3.4 |
|  | A1 | 1.1b |
| , and  | M1 | 3.1b |
| 07:32 and 12:06 | A1 | 1.1b |
|  |  | A1 | 3.2a |
|  |  | **(5)** |  |
| **(e)** | Valid limitation | B1 | 3.5b |
|  | **(1)** |  |
| **(13 marks)** |

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| **Notes**1. M1: Attempts to find a value for and .A1: A correct, exact value for .A1: a.w.r.t 0.322
2. B1: Accept a.w.r.t. 12.4
3. M1: Applies M1: RHS = , solves to find .

A1: Accept “16 hours and 6 minutes after midnight”.1. M1: Sets their and simplifies to

A1: One correct value of  within the range.M1: Solves their equation to obtain two positive values of .A1: Accept a.w.r.t 7.5 and 12A1: Accept 07:32 or “7 hours 32 minutes after midnight” AND 12:06 or “12 hours 6 minutes after midnight”B1: eg: The causeway may not be level. eg: Maximum height may vary with the seasons. eg: The high-low tide cycle may not be exactly 12.5 hours. |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **19(a)** | and an attempt to solve for *k* =  | M1 | 3.1a |
| A correct use of logarithms to get as far a correct intermediate answer such as  or  | A1 | 1.1b |
|   | A1 | 3.3 |
|  |  | **(3)** |  |
| **(b)** |  f.t. their *k* | M1 | 3.4 |
| *v* = 0. 48 ms-1 | A1 | 1.1b |
|  |  | **(2)** |  |
| **(c)** | Makes a suitable comment on the accuracy of the model E.g. Not a good model (for larger values of *t*) as there is a difference of around 20% | B1 ft | 3.5a |
|  |  | **(1)** |  |
| **(d)** | Suggest a suitable limitation. E.g. The model predicts the speed will always increaseThe model suggests that the speed will never go above 0.5 | B1 | 3.5b |
|  |  | **(1)** |  |
| **(7 marks)** |
| **Notes**(a)M1: Proceeds to = a positive, condoning slipsA1: awrt 0.805 but condone exact values A1: o.e.(b)M1: Uses their model with *t* = 4A1: *v* = 0. 48 ms-1(c)B1: Condone “Therefore it is a good model” if they state that 20% is quite good.(d)B1: Statement must be correct and verifiable from the given model so statements like “model does not take friction/resistance into account” will score B0. |