**Paper 1: Core Pure Mathematics Mark Scheme**

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **1(a)** |  | M1 | 1.1b |
| A1 | 1.1b |
|  | M1 | 3.1a |
|  | A1 | 1.1b |
| Hence the roots of  are | A1 | 2.2a |
|  | **(5)** |  |
| **(b)** |  | M1 | 3.1a |
| cso | A1 | 1.1b |
|  | **(2)** |  |
| **1(b) alternative** |  | |
|  | M1 | 3.1a |
| cso | A1 | 1.1b |
|  | **(2)** |  |
| **(7 marks)** | | | |
| **Notes:** | | | |
| **(a)**  **M1:**  Multiplies the three given roots together and sets the result equal to 15 or  **A1:** Obtains a correct equation in  **M1:**  Forms a quadratic equation in  and attempts to solve this equation by either completing  the square or using the quadratic formula to give  **A1:**  **A1:** Deduces the roots are | | | |
| **(b)**  **M1:** Applies the process of finding  to give  **A1:**  by correct solution only | | | |
| **(b) Alternative**  **M1:** Applies the process expanding  in order to find  **A1:**  by correct solution only | | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **2(a)** |  | M1 | 1.1b |
|  | A1 | 2.5 |
|  | **(2)** |  |
| **(b)** |  | B1 | 1.1b |
|  | M1 | 1.1b |
|  | M1 | 2.1 |
| \* cso | A1\* | 1.1b |
|  | **(4)** |  |
| **(c)** |  | M1 | 3.1a |
|  | A1 | 1.1b |
|  | M1 | 1.1b |
|  | A1ft | 1.1b |
|  | **(4)** |  |
| **(10 marks)** | | | |
| **Notes:** | | | |
| **(a)**  **M1:**  Attempts to apply the formula  **A1:** Correct Cartesian notation. e.g.  **Note:** Do not allow final answer given as  o.e. | | | |
| **(b)**  **B1:**  **M1:** An attempt to apply the correct dot product formula between **n** and **d**  **M1:** Depends on previous M mark. Applies the dot product formula to find the angle between  and  **A1\*:** cso | | | |

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| **Question 2 notes continued:** |
| **(c)**  **M1:** Substitutes  into  and solves the resulting equation to give  **A1:**  o.e.  **M1:** Depends on previous M mark. Substitutes theirinto  and finds at least one of the  coordinates  **A1ft:** |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **3** | *x* = value of savings account, *y* = value of property bond account*,*  *z* = value of share dealing account      **or** | M1 | 3.1b |
| A1 | 1.1b |
| Let |  |  |
| e.g. | M1 | 3.1a |
| A1 | 1.1b |
|  | M1 | 1.1b |
|  | A1 | 1.1b |
| Tyler invested £1800 in the savings account, £2200 in the property bond account and £1000 in the share dealing account | A1ft | 3.2a |
| **(7 marks)** | | | |
| **Notes:** | | | |
| **M1:** Attempts to set up 3 equations with 3 unknowns  **A1:** At least 2 equations are correct with the appropriate variables defined  **M1:** Sets up a matrix equation of the form, e.g., where “…” are  numerical values  **A1:** Correct matrix equation (or equivalent)  **M1:**  Depends on previous M mark. Applies  and obtains at least one  value of *x*, *y* or *z*  **A1:** Correct answer  **A1ft:** Correct follow through answer in context | | | |

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| **Question** | **Scheme** | **Marks** | | **AOs** |
| **4** |  | B1 | | 3.1a |
|  | M1 | | 3.1a |
|  |  | |  |
|  | M1 | | 1.1b |
| A1 | | 1.1b |
| A1 | | 1.1b |
|  | **(5)** | |  |
| **Alternative** | |  | |
|  | B1 | | 3.1a |
|  | M1 | | 3.1a |
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|  |
|  | M1 | | 1.1b |
| A1 | | 1.1b |
| A1 | | 1.1b |
|  | **(5)** | |  |
|  | **(5 marks)** | | | |
| **Notes:** | | | | |
| **B1:** Selects the method of making a connection between *x* and *w* by writing  **M1:** Applies the process of substituting their into  **M1:** Depends on previous M mark. Manipulating their equation into the form    **A1:** At least two of *p*, *q*, *r* are correct  **A1:** Correct final equation | | | | |
| **Alternative**  **B1:** Selects the method of giving three correct equations each containing  **M1:** Applies the process of finding sum roots, pair sum and product  **M1:** Depends on previous M mark. Applies    **A1:** At least two of *p*, *q*, *r* are correct  **A1:** Correct final equation | | | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **5(a)** |  | M1 | 1.1a |
| **M** is non-singular because and so | A1 | 2.4 |
|  | **(2)** |  |
| **(b)** |  | B1ft | 1.2 |
|  | **(1)** |  |
| **(c)** |  | M1 | 1.1b |
|  | A1ft | 1.1b |
|  | **(2)** |  |
| **(d)** |  | M1 | 1.1b |
|  | A1 | 1.1b |
|  | **(2)** |  |
| **(7 marks)** | | | |
| **Notes:** | | | |
| **(a)**  **M1:** An attempt to find  **A1:**  **and** reference to zero, e.g.  **and** conclusion. | | | |
| **(b)**  **B1ft:** 20 or a correct ft based on their answer to part (a). | | | |
| **(c)**  **M1:**  **A1ft:** 2 | | | |
| **(d)**  **M1:** **Either**  **or**  **or**  **A1:**  Also accept any value satisfying  o.e. | | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **6(a)** | and | B1 | 2.2a |
| Assume general statement is true for  So assume  is true | M1 | 2.4 |
|  | M1 | 2.1 |
|  | A1 | 1.1b |
|  | A1 | 1.1b |
| Then the general result is  As the general result has been shown to be then the general result is true for all *n* | A1 | 2.4 |
|  | **(6)** |  |
| **(b)** |  |  |  |
|  | M1 | 2.1 |
| A1 | 1.1b |
|  | M1 | 1.1b |
| cso | A1\* | 1.1b |
|  | **(4)** |  |
| **(c)** |  | M1 | 1.1b |
|  | M1 | 1.1b |
|  | A1 | 1.1b |
|  | M1 | 1.1b |
| (As *n* must be a positive integer,) | A1 | 2.3 |
|  | **(5)** |  |
| **(15 marks)** | | | |

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| **Question 6 notes:** |
| **(a)**  **B1:** Checks  works for both sides of the general statement  **M1:** Assumes (general result) true for  **M1:** Attempts to add (*k* + 1)th  term to the sum of *k* terms  **A1:** Correct algebraic work leading to **either**  **or**  **or**  **A1:** Correct algebraic work leading to  **A1:** cso leading to a correct induction statement conveying all three underlined points |
| **(b)**  **M1:** Substitutes at least one of the standard formulae into their expanded expression  **A1:** Correct expression  **M1:** Depends on previous M mark. Attempt to factorise at least having used  **A1\*:** Obtains  by cso |
| **(c)**  **M1:** Sets their part (a) answer equal to  **M1:** Cancels out from both sides of their equation  **A1:**  **M1:** A valid method for solving a 3 term quadratic equation  **A1:** Only one solution of |

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| **Question** | **Scheme** | | **Marks** | **AOs** |
| **7(a)** | Depth = 0.16 (m) | | B1 | 2.2b |
|  | | **(1)** |  |
| **(b)** |  | | M1 | 3.3 |
|  | | A1 | 1.1b |
|  | | **(2)** |  |
| **(c)** |  |  | B1ft | 1.1a |
|  |  | M1 | 3.3 |
|  |  | M1 | 1.1b |
| A1 | 1.1b |
|  |  |  |  |
|  | | B1 | 1.1b |
|  | | M1 | 3.4 |
|  | | A1 | 1.1b |
|  | | **(7)** |  |
| **(d)** | Any one of e.g.  the measurements may not be accurate  the inside surface of the bowl may not be smooth  there may be wastage of concrete when making the bird bath | | B1 | 3.5b |
|  | | **(1)** |  |
| **(e)** | Some comment consistent with their values. We do need a reason    so not a good estimate because the volume of concrete needed to make the bird bath is approximately 7% lower than that predicted by the model  **or**  We might expect the actual amount of concrete to exceed that which the model predicts due to wastage, so the model does not look suitable since it predicts more concrete than was used | | B1ft | 3.5a |
|  | | **(1)** |  |
| **(12 marks)** | | | | |

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| **Question 7 notes:** |
| **(a)**  **B1:** Infers that the maximum depth of the bird bath could be 0.16 (m) |
| **(b)**  **M1:** Substitutes  and  or  into  and rearranges to give  **A1:**  cao |
| **(c)**  **B1ft:** Uses the model to obtain either  **or**  **M1:** Chooses limits that are appropriate to their model  **M1:** Integrates  (with respect to *y*) to give  where  is a constant  **A1:** Uses their model correctly to give either  or  **B1:**  or  **or**  o.e.  **M1:** Depends on **both** previous M marks  Uses the model to find  their integrated volume  **A1:** 0.136 cao |
| **(d)**  **B1:** States an acceptable limitation of the model |
| **(e)**  **B1ft:** Compares the actual volume with their answer to (c). Makes an assessment of the model.  E.g. evaluates the percentage error and uses this to make a sensible comment about the  model with a reason |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **8(a)** |  | M1 | 1.1b |
| A1 | 1.1b |
| M1 | 1.1b |
| A1 | 2.2a |
| M1 | 3.1a |
| A1 | 1.1b |
|  | **(6)** |  |
| **(b)** |  | M1 | 3.1a |
| **cao** | A1 | 1.1b |
|  | **(2)** |  |
| **(8 marks)** | | | |
| **Notes:** | | | |
| **(a)**  **M1:** Circle  **A1:** Centre (0, 4) and above the real axis  **M1:** Half-line  **A1:** (3, 4) positioned correctly and the half-line intersects the top of the circle on the *y*-axis  **M1:** Depends on **both** previous M marks Shades in a region inside the circle and below the  half-line  **A1:** cso  **Note:** Final A1 mark is dependent on all previous marks being scored in part (a) | | | |
| **(b)**  **M1:** Uses trigonometry to give an expression for an angle in the  range  or ( 90º, 180º )  **A1:** 2.42 cao | | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **9(a)** | or | M1 | 3.1a |
|  | M1 | 1.1b |
|  | dM1 | 1.1b |
|  | A1 | 1.1b |
| and minimum distance | dM1 | 3.1a |
| **or** 2.449… | A1 | 1.1b |
| so the octopus is not able to catch the fish *F* | A1ft | 3.2a |
|  | **(7)** |  |

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| **Question** | **Scheme** | **Marks** | |
|  | **9(a) Alternative 1** |  | |
| or | M1 | 3.1a |
|  | M1 | 1.1b |
|  | dM1 | 1.1b |
|  |  |  |
|  | A1 | 1.1b |
| minimum distance | dM1 | 3.1a |
| or 2.449… | A1 | 1.1b |
| so the octopus is not able to catch the fish *F* | A1ft | 3.2a |
|  | **(7)** |  |
| **9(a) Alternative 2** |  | |
| or | M1 | 3.1a |
|  | M1 | 1.1b |
|  | dM1 | 1.1b |
|  |  |  |
|  | A1 | 1.1b |
|  | dM1 | 3.1a |
| minimum distance  or 2.449… | A1 | 1.1b |
| so the octopus is not able to catch the fish *F* | A1ft | 3.2a |
|  | **(7)** |  |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **9(b)** | e.g.  Fish *F* may not swim in an exact straight line from *A* to *B*  Fish *F* may hit an obstacle whilst swimming from *A* to *B*  Fish *F* may deviate his path to avoid being caught by the octopus | B1 | 3.5b |
|  | **(1)** |  |
| **(c)** | e.g.  Octopus is effectively modelled as a particle – so we may need to look at where the octopus’s mass is distributed  Octopus may during the fish *F*’s motion move away from its fixed location at *O* | B1 | 3.5b |
|  | **(1)** |  |
| **(9 marks)** | | | |
| **Question 9 notes:** | | | |
| **(a)**  **M1:** Attempts to find  **or**  **or** the direction vector **d**  **M1:** Applies  or equivalent  **M1:** Depends on previous M mark. Writes down  Can be implied  **A1:** Lambda is correct. e.g.  for  or  for  **M1:** Depends on previous M mark. Complete method for finding  **A1:**  **or** awrt 2.4  **A1ft:** Correct follow through conclusion, which is in context with the question | | | |
| **Alternative 1**  **(a)**  **M1:** Attempts to find  **or**  **or** the direction vector **d**  **M1:** Realisation that the dot product is required between  and their  (o.e.)  **M1:** Depends on previous M mark. Applies dot product formula between  and their  (o.e.)  **A1:**  or  **M1:** Depends on previous M mark.  **A1:**  or awrt 2.4  **A1ft:** Correct follow through conclusion, which is in context with the question | | | |

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| **Question 9 notes continued:** |
| **Alternative 2**  **(a)**  **M1:** Attempts to find  **or**  **or** the direction vector **d**  **M1:** Applies  or equivalent  **M1:** Depends on previous M mark. Applies Pythagoras by finding  **A1:**  **M1:** Depends on previous M mark. Method of completing the square or differentiating their  w.r.t.  **A1:**  or awrt 2.4  **A1ft:** Correct follow through conclusion, which is in context with the question |
| **(b)**  **B1:** An acceptable criticism for fish F, which is in context with the question |
| **(c)**  **B1:** An acceptable criticism for the octopus, which is in context with the question |