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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **1** |  | **M1** | 1.1b | 2nd  Understand the concept of singular and non singular matrices |
|  |  | **M1** | 2.2a |  |
|  | Concludes that (*p* + 2)2 + 2 > 0 for all values of *p*. Therefore det **M** ≠ 0 and **M** is non-singular. | **B1** | 3.2a |  |
| (3 marks) | | | | |
| **Notes** | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **2** |  | **M1** | 1.1b | 3rd  Multiply two multiplicatively conformable matrices |
| Deduces that 21*a* – 168 = 0 and solves to find *a* = 8 | **A1\*** | 2.2a |
| Deduces that *a*2 + 21*b* = 1 and solves to find *b* = −3 | **A1\*** | 2.2a |
| (3 marks) | | | | |
| Notes  **2** Can use any of the following equations to find *a* and *b*. Award 1 mark for finding *a* and 1 mark for finding *b*.  *a*2 + 21*b* = 1  21*a* – 168 = 0  *ab* – 8*b* = 0  21*b* + 64 = 1 | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **3a** |  | **M1** | 1.1b | 4th  Represent rotations in two dimensions using matrices |
| Finds *θ* = 150° and concludes this is a rotation of 150° anticlockwise about the origin. | **B1** | 3.2a |
|  | **(2)** |  |  |
| **3b** | Sets up a matrix equation of the form:  or two separate equations of the form  and | **M1** | 1.1a | 3rd  Multiply two multiplicatively conformable matrices |
| Finds  or  and | **M1** | 1.1b |
| States *P*′ and *Q*′ | **A1** | 3.2a |
|  | **(3)** |  |  |

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| **3c** |  | **M1** | 1.1b | 4th  Represent rotations in two dimensions using matrices |
|  | **M1** | 1.1b |
| Finds *θ* = 300° and concludes this is a rotation of 300° anticlockwise about the origin.  or  Finds *θ* = −60° and concludes that it is a rotation of 60° clockwise about the orgin. | **B1** | 3.2a |
|  | **(3)** |  |  |
| (8 marks) | | | | |
| Notes | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **4a** | Reflection in the line *y* = −*x* | **B1** | 3.2a | 4th  Represent reflections in two dimensions using matrices |
|  | **(1)** |  |  |
| **4b** | Calculates | **M1** | 1.1b | 3rd  Multiply two multiplicatively conformable matrices |
| States or implies −*b* = 4 + 2*a* and −*b* = 4 + 2*a* = 5 + *b* | **M1** | 2.2a |
| Finds *a* = 1 and *b* = −6 | **A1** | 1.1b |
|  | **(3)** |  |  |
| (4 marks) | | | | |
| **Notes** | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **5** |  | **M1** | 1.1b | 4th  Represent enlargements in two dimensions using matrices |
| States that this is an enlargement. | **A1** | 3.2a |
| States scale factor is *q*2 + 5 and centre is (0, 0). | **A1** | 3.2a |
| (3 marks) | | | | |
| **Notes** | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **6a** | Writes the matrix representing a reflection in the plane *y* = 0: | **B1** | 3.1a | 4th  Represent reflections in two dimensions using matrices |
|  | **(1)** |  |  |
| **6b** | Finds the midpoint of the line segment = (5, 5, 9) | **M1** | 1.1b | 3rd  Multiply two multiplicatively conformable matrices |
| Makes an attempt to calculate  Minimum required is setting up the calculation. | **M1** | 2.2a |
| Correctly finds the coordinates (5, −5, 9) | **A1** | 3.1b |
|  | **(3)** |  |  |
| **6c** | States or implies that **N** is the inverse of **M**. | **M1** | 2.2a | 3rd  Calculate the inverse of a 3 by 3 matrix |
|  | **A1** | 1.1b |
|  | **(2)** |  |  |
| (6 marks) | | | | |
| Notes | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **7a** |  | **M1** | 1.1a | 2nd  Understand the concept of singular and non singular matrices |
|  | **M** is non-singular because det (**M**) = 3 and so det (**M**) ≠ 0 | **A1** | 2.4 |  |
|  |  | **(2)** |  |  |
| **7b** | Area (*S*) = 3 × 20 = 60 | **B1 ft** | 1.2 | 4th  Understand the determinant of a matrix represents the area scale factor of enlargement |
|  |  | **(1)** |  |  |
| **7c** |  | **M1** | 1.1b | 5th  Represent successive transformations in two dimensions using matrices |
|  | States | **A1 ft** | 1.1b |  |
|  |  | **(2)** |  |  |
| **7d** |  | **M1** | 1.1b | 5th  Represent successive transformations in two dimensions using matrices |
|  | *θ* = 125.3° Accept answers which round to 125.3° | **A1** | 1.1b |  |
|  |  | **(2)** |  |  |
| (7 marks) | | | | |
| Notes | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **8a** |  | **M1** | 1.1b | 4th  Represent rotations in three dimensions using matrices |
| Finds *θ* = 240° and concludes this is a rotation of 240° anticlockwise about the *z*‑axis. | **B1** | 3.2a |
|  | **(2)** |  |  |
| **8b** | Makes an attempt to calculate  Minimum required is setting up the calculation. | **M1** | 1.1b | 6th  Solve problems involving unknown elements using matrix transformations |
| Correctly finds | **A1** | 1.1b |
|  | **(2)** |  |  |
| (4 marks) | | | | |
| Notes | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **9** | Attempts to set up three equations with three unknowns. | **M1** | 3.1b | 5th  Use inverse matrices to solve a system of three simultaneous equations |
| At least two equations are correct, with variables defined.  *x* = area of residential land  *y* = area of commercial land  *z* = area of recreational land | **A1** | 1.1b |
| Sets up a matrix equation of the form, , where ‘…’ are numerical values. | **M1** | 3.1a |
| States the correct matrix equation: | **A1** | 1.1b |
| Attempts to use an inverse matrix to find the values of *x*, *y* and *z*. | **M1** | 1.1b |
| Finds the correct answers for *x*, *y* and *z*: | **A1** | 1.1b |
| Puts their answer into context. In 2001, there were 140 square kilometres assigned to residential, 20 square kilometres assigned to commerical and 40 square kilometres assigned to recreation. | **A1 ft** | 3.2a |
| (7 marks) | | | | |
| **Notes**  **9**  Note the inverse matrix of  is | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **10a** | States either or  or | **M1** | 1.1b | 4th  Represent rotations in two dimensions using matrices |
| Finds *θ* = 135° and concludes this is a rotation of 135° anticlockwise about the origin.  or  Finds *θ* = −45° and concludes this is a rotation of 45° clockwise about the origin. | **B1** | 3.2a |
|  | **(2)** |  |  |
| **10b** |  | **M1** | 1.1b | 5th  Solve problems involving transformations and their inverses in two dimensions |
|  | **M1** | 3.1a |
| Correctly solves to find *a* = 4 and *b* = −2 | **A1** | 1.1b |
|  | **(3)** |  |  |
| (5 marks) | | | | |
| Notes | | | | |