

Question	Scheme	Marks	AOs
5(a)	Rotation	B1	1.1b
	120 degrees (anticlockwise) or $\frac{2\pi}{3}$ radians (anticlockwise) Or 240 degrees clockwise or $\frac{4\pi}{3}$ radians clockwise	B1	2.5
	About (from) the origin. Allow (0, 0) or <i>O</i> for origin.	B1	1.2
		(3)	
(b)	$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	B1	1.1b
		(1)	
(c)	$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{pmatrix} = \begin{pmatrix} \dots & \dots \\ \dots & \dots \end{pmatrix}$	M1	1.1b
	$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{pmatrix} = \begin{pmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{pmatrix}$	A1ft	1.1b
		(2)	
(d)	$\begin{pmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{pmatrix} \begin{pmatrix} 1 \\ k \end{pmatrix} = \begin{pmatrix} 1 \\ k \end{pmatrix} = \dots$ or $\begin{pmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} x \\ y \end{pmatrix} = \dots$	M1	3.1a
	Note: $\begin{pmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{pmatrix} \begin{pmatrix} 1 \\ k \end{pmatrix} = \begin{pmatrix} -\frac{\sqrt{3}}{2} + \frac{1}{2}k \\ \frac{1}{2} + \frac{\sqrt{3}}{2}k \end{pmatrix} = \begin{pmatrix} 1 \\ k \end{pmatrix}$ can score M1 (for the matrix equation) but needs an equation to be “extracted” to score the next A1		
	$-\frac{\sqrt{3}}{2} + \frac{1}{2}k = 1$ or $\frac{1}{2} + \frac{\sqrt{3}}{2}k = k$ or $x = -\frac{\sqrt{3}}{2}x + \frac{1}{2}y$ or $y = \frac{1}{2}x + \frac{\sqrt{3}}{2}y$ (Note that candidates may then substitute $x = 1$ which is acceptable)	A1ft	1.1b
	$-\frac{\sqrt{3}}{2} + \frac{1}{2}k = 1$ or $x = -\frac{\sqrt{3}}{2}x + \frac{1}{2}y \Rightarrow k = 2 + \sqrt{3}$ (or $\frac{1}{2 - \sqrt{3}}$)	A1	1.1b
	$\frac{1}{2} + \frac{\sqrt{3}}{2}k = k$ or $y = \frac{1}{2}x + \frac{\sqrt{3}}{2}y \Rightarrow k = 2 + \sqrt{3}$ (or $\frac{1}{2 - \sqrt{3}}$)	B1	1.1b
	(4)		
(10 marks)			

Notes

(a)

B1: Identifies the transformation as a rotation

B1: Correct angle. Allow equivalents in degrees or radians.

B1: Identifies the origin as the centre of rotation

These marks can only be awarded as the elements of a **single transformation**

(b)

B1: Shows the correct matrix in the correct form

(c)

M1: Multiplies the matrices in the correct order (evidence of multiplication can be taken from 3 correct or 3 correct ft elements)

A1ft: Correct matrix (follow through their matrix from part (b))

A correct matrix or a correct follow through matrix implies both marks.

(d)

M1: Translates the problem into a matrix multiplication to obtain at least one equation in k or in x and y

A1ft: Obtains one correct equation (follow through their matrix from part (c))

A1: Correct value for k in any form

B1: Checks their answer by independently solving both equations **correctly** to obtain $2+\sqrt{3}$ both times or substitutes $2+\sqrt{3}$ into the other equation to confirm its validity