Question	Scheme		Marks	AOs
4 (i)	$\begin{pmatrix}2 & 1\\3 & 4\end{pmatrix}\begin{pmatrix}x\\y\end{pmatrix} = \begin{pmatrix}x\\y\end{pmatrix} \Rightarrow \begin{matrix}y=-x\\y=-x\end{matrix} \Rightarrow y=-x$		B1	1.1b
			(1)	
(ii) (a)	$\begin{pmatrix}3 & -1\\3 & 4\end{pmatrix}\begin{pmatrix}x\\mx+c\end{pmatrix} = \begin{pmatrix}X\\mX+c\end{pmatrix}$ leading to an equation in x, m, c and X		M1	3.1a
	$3x-(mx+c)=X$ and $3x+4(mx+c)=mX+c$		A1	1.1b
	$3x+4(mx+c)=m(3x-(mx+c))+c$ $(3+4m=3m-m^2)$ $(4c=-mc+c)$ leading to $m^2+m+3=0$ $\Rightarrow b^2-4ac = (1)^2-4(1)(3)=\ldots$ Alternatively, solves $4c=-mc+c \Rightarrow m=\ldots$		dM1	2.1
	Correct expression for the discriminant = $\{-11\}<0$ therefore there are no invariant lines.	$m=-3$ and shows a contradiction in $3+4m=3m-m^2$ therefore there are no invariant lines.	A1	2.4
			(4)	
	<u>Alternative</u> $\begin{pmatrix}3 & -1\\3 & 4\end{pmatrix}\begin{pmatrix}x\\mx\end{pmatrix} = \begin{pmatrix}X\\mX\end{pmatrix}$ leading to an equation in x, m and X		M1	3.1a
	$3x-(mx)=X$ and $3x+4(mx)=mX$		A1	1.1b
	$3x+4(mx)=m(3x-(mx))$ leading to $3+4m=3m-m^2$ $m^2+m+3=0 \Rightarrow b^2-4ac=(1)^2-4(1)(3)=\ldots$		dM1	2.1
	Correct expression for the discriminant $=\{-11\}<0$ therefore there are no invariant lines that pass through the origin so no invariant lines.		A1	2.4
			(4)	
(ii) (b)	det **M** = 15		B1	1.1b
	Area of original triangle $=\left\lvert\frac{1}{2}(8-k)2\right\rvert$ $\lvert 8-k\rvert = 75 \div \text{“}15\text{”} \Rightarrow k=\ldots$		M1	3.1a
	$k=3$ **or** $k=13$		A1	1.1b

	$k = 3$ **and** $k = 13$	A1	1.1b
		(4)	
			(9 marks)

Notes

(i)

B1: Correct line

(ii) (a)

M1: Sets up a matrix equation in an attempt to find a fixed line and extracts at least one equation.

A1: Correct equations.

dM1: Eliminates *X* from the simultaneous equations and equates the coefficients of *x* leading to a quadratic equation in terms of *m*, then finds the value of the discriminant, which can be seen in an attempt to solve the quadratic using the formula.

Alternatively solves $4c = -mc + c$ and finds a value for m

Note: If the quadratic equation in *m* is solved on a calculator and complex roots given this is M0 as they are not showing why there are no real roots.

A1: Correct expression for the discriminant, states < 0 and draws the required conclusion. Alternatively, correct value for *m*, shows a contradiction in $3 + 4m = 3m - m^2$ and draws the required conclusion.

Alternative

M1: Sets up a matrix equation in an attempt to find a fixed line and extracts at least one equation.

A1: Correct equations.

dM1: Eliminates *X* from the simultaneous equations and equates the coefficients of *x* leading to a quadratic equation in terms of *m*. then finds the value of the discriminant which can be seen in an attempt to solve the quadratic using the formula.

A1: Correct expression for the discriminant, states < 0 and draws the required conclusion.

(ii) (b)

B1: det **M** = 15 oe eg det **M** = 12 – (– 3) or det **M** = 3 (4) – (– 1)(3)

M1: Finds an expression in terms of *k* for the area of the original triangle and equates this to $\frac{75}{\text{"their determinant"}}$, proceeding to find at least one value for k

A1: $k = 3$ **or** $k = 13$

A1: Both values correct