Question	Scheme	Marks	AOs
3(a)	$\begin{pmatrix}3 & 3\\ 4 & 7\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}x\\ y\end{pmatrix}\Rightarrow \begin{matrix}3x+3y=x\\ 4x+7y=y\end{matrix}$	M1	1.1b
	$\Rightarrow \begin{matrix}2x=-3y\\ 4x=-6y\end{matrix}\Rightarrow y=-\frac{2}{3}x$	M1	1.1b
	So the invariant points of the transformation are precisely those points lying on the line $y=-\frac{2}{3}x$.	A1	2.4
		(3)	
(b)	$\begin{pmatrix}3 & 3\\ 4 & 7\end{pmatrix}\begin{pmatrix}x\\ mx+c\end{pmatrix}=\begin{pmatrix}x'\\ mx'+c\end{pmatrix}\Rightarrow \begin{matrix}3x+3(mx+c)=x'\\ 4x+7(mx+c)=mx'+c\end{matrix}$	M1	3.1a
	$\Rightarrow 4x+7(mx+c)=m(3x+3mx+3c)+c\Rightarrow (..)x+..=..$	M1	1.1b
	$\Rightarrow (4+7m-3m-3m^2)x+7c=3mc+c$ (oe)	A1	1.1b
	$\Rightarrow (2-m)(2+3m)x+3c(2-m)=0\Rightarrow (2-m)\big((2+3m)x+3c\big)=0$ $\Rightarrow m-2=0$ or both $2+3m=0$ and $c=0$ (since the equation must hold for all x to give fixed lines)	M1	3.1a
	Since the equations are satisfied whenever $m = 2$, the lines $y = 2x+c$ are invariant lines under T.	A1	2.4
	Also, as the equation holds when $m = -2/3$ and $c = 0$, the line $y=-\frac{2}{3}x$ is invariant – or notes that this line is invariant as all the points on it are invariant as shown in (a).	B1	2.2a
		(6)	
			(9 marks)

Notes:

(a)

M1: Sets up a matrix equation to find the fixed points and extracts a pair of simultaneous equations. (May just see the simultaneous equations.)

M1: Solves the equations showing the same solution comes from both.

A1: Describes the invariant points as those on the line $y=-\frac{2x}{3}$.

(b)

M1: Sets up a matrix equation to find the fixed lines and extracts a pair of simultaneous equations.

M1: Substitutes for x' and expands and gathers terms in x.

A1: Correct equation with terms in x gathered.

M1: Factorises the quadratic in m and factors out the common term – cancelling the term without consideration of it is M0. Since the equation must hold for any x they must deduce this occurs when the factor $m - 2 = 0$ or when $(3m + 2) = 0$ and $c = 0$.

A1: Explains that when $m = 2$ the line is fixed so the lines $y = 2x + c$ for any c are invariant under T...

B1: … and the line $y=-\frac{2x}{3}$ is also invariant since this satisfies $m=-\frac{2}{3}$ and $c = 0$, or since all the points on it are invariant from (a). This mark is not dependent on any others so can be scored if they deduce this line is invariant directly from (a).