Question	Scheme	Marks	AOs
3(a)	$\mathbf{M}^2+11\mathbf{M}=\begin{pmatrix} a & 0 \\ 0 & a \end{pmatrix} \Rightarrow \begin{pmatrix} 34 & 5k-10 \\ 6k-12 & k^2+30 \end{pmatrix}+\begin{pmatrix} -22 & 55 \\ 66 & 11k \end{pmatrix}=\begin{pmatrix} a & 0 \\ 0 & a \end{pmatrix}$	M1	1.1b
	$\Rightarrow a=12$	A1	2.2a
	$5k-10+55=0 \Rightarrow 5k=-45 \Rightarrow k=-9^*$ or $6k-12+66=0 \Rightarrow 6k=-54 \Rightarrow k=-9^*$ or $k^2+11k+30=12 \Rightarrow k^2+11k+18=0 \Rightarrow k=-2,-9^*$, $k \neq -2$ as $4\times -2-10+55 \neq 0$	A1*	2.1
		(3)	
(b)	$\begin{pmatrix} -2 & 5 \\ 6 & -9 \end{pmatrix}\begin{pmatrix} x \\ mx+c \end{pmatrix}=\begin{pmatrix} X \\ mX+c \end{pmatrix} \Rightarrow \begin{cases} -2x+5(mx+c)=X \\ 6x-9(mx+c)=mX+c \end{cases}$	M1	1.1b
	$\Rightarrow 6x-9mx-9c=-2mx+5m^2x+5mc+c$	M1	3.1a
	$\Rightarrow (5m^2+7m-6)x+(5m+10)c=0$	A1	1.1b
	$\Rightarrow 5m^2+7m-6=0 \Rightarrow (m+2)(5m-3) \Rightarrow m=-2,\frac{3}{5}$	M1	1.1b
	$m=\frac{3}{5} \Rightarrow 5m+10 \neq 0$ so need $c=0$ hence $y=\frac{3}{5}x$ is a fixed line	A1	2.2a
	$m=-2 \Rightarrow 5m+10=0$ so c can be anything, so $y=-2x+c$ for any c is fixed.	A1	2.2a
		(6)	
(c)	($(0,c) \rightarrow (5c,-9c)$ so need c = 0,) $(1,m) \rightarrow (-2+5m, 6-9m)$ so need $5m=3$ hence $y=\frac{3}{5}x$ contains fixed points.	B1	3.2a
		(1)	
		(10 marks)	

Notes:

(a)

M1: Evaluates $\mathbf{M}^2$ and uses in the equation given.

A1: Correct value of *a* deduced from upper left entries.

A1*: Correct work to show $k=-9$. If off diagonals are used no further justification is needed (they are "given" the result is true). If the bottom right entry is used there must be a valid reason for rejecting -2 as a solution (ie checking the off diagonal).

(b)

M1: Sets up the matrix equation for invariant lines and extracts the simultaneous equations from the matrix equation.

M1: Eliminates "*X*" to get a linear equation in "*x*".

A1: Correct equation.

M1: Solves the equation in *m* by any valid means.

A1: Deduces $y=\frac{3}{5}x$ is a fixed line (where *c* = 0). If the value for *m* here is wrong, allow this A for $y=-2x$ if the general case for the final A is not scored.

A1: Deduces $y=-2x+c$ is a fixed line where *c* can be any value. Must include all the lines.

(c)

B1: Identifies $y=\frac{3}{5}x$ is a line of fixed points with reason. Allow if *c* = 0 is assumed. See scheme for one possible reason, others may be given.