Question	Scheme	Marks
6(a)	$\begin{pmatrix}-2 & 2 & 2\\ -3 & -7 & -3\\ 1 & 1 & -3\end{pmatrix}\begin{pmatrix}1\\ 0\\ -1\end{pmatrix}=\begin{pmatrix}-2-2\\ -3+3\\ 1+3\end{pmatrix}=\ldots$	M1
	$=\begin{pmatrix}-4\\ 0\\ 4\end{pmatrix}=-4\times\begin{pmatrix}1\\ 0\\ -1\end{pmatrix}$ has an eigenvector	A1
	Eigenvalue is -4	B1
		(3)
(b)	$\begin{vmatrix}-2-\lambda & 2 & 2\\ -3 & -7-\lambda & -3\\ 1 & 1 & -3-\lambda\end{vmatrix}=(-2-\lambda)\begin{vmatrix}-7-\lambda & -3\\ 1 & -3-\lambda\end{vmatrix}-2\begin{vmatrix}-3 & -3\\ 1 & -3-\lambda\end{vmatrix}+2\begin{vmatrix}-3 & -7-\lambda\\ 1 & 1\end{vmatrix}=$ $=(-2-\lambda)\left((-7-\lambda)(-3-\lambda)+3\right)-2\left(-3(-3-\lambda)+3\right)+2\left(-3-(-7-\lambda)\right)$	M1A1
	$0=(-2-\lambda)\left(24+10\lambda+\lambda^2\right)-2(2\lambda+8)$ $=-\lambda^3-12\lambda^2-48\lambda-64$	M1
	$\Rightarrow-(\lambda+4)\left(\lambda^2+8\lambda+16\right)=-(\lambda+4)^3=0\Rightarrow\lambda=-4$ only	A1
		(4)
(c)	$\begin{pmatrix}-2 & 2 & 2\\ -3 & -7 & -3\\ 1 & 1 & -3\end{pmatrix}\begin{pmatrix}1+t\\ 2t-1\\ -3t\end{pmatrix}=\ldots$	M1
	$=\begin{pmatrix}-2-2t+4t-2-6t\\ -3-3t-14t+7+9t\\ 1+t+2t-1+9t\end{pmatrix}=\begin{pmatrix}-4-4t\\ 4-8t\\ 12t\end{pmatrix}$	A1
	Image line is $\dfrac{x+4}{-4}=\dfrac{y-4}{-8}=\dfrac{z}{12}$	M1A1
		(4)
		(11 marks)

Notes:

(a)

M1: Multiplies the matrix by the given vector, at least two correct entries.

A1: Correct resulting vector and shows it is a multiple of the original vector.

B1: Correct eigenvalue identified. Allow simply $\lambda=-4$

(b)

Note: allow the marks for (b) to score if seen in part (a)

M1: Expands $\det(\mathbf{M}-\lambda\mathbf{I})$ fully to a cubic (need not be expanded).

A1: Fully correct expansion (need not be simplified).

M1: Sets $\det(\mathbf{M}-\lambda\mathbf{I})=0$ and simplifies to the cubic. May identify a factor of $\lambda+4$ in each term – allow the M for identifying this. $0=(-2-\lambda)(\lambda+4)(\lambda+6)-4(\lambda+4)=(\lambda+4)(-\lambda^2-8\lambda-16)$

A1: Reaches the cubed form and deduces only one eigenvalue. Must show the result by either fully factorising the correct cubic, or factorising the correct quadratic after the correct cubic is seen.

(c)

M1: Attempts the parametric form of the line and multiplies by the matrix **M**.

A1: Correct result of the multiplication.

M1: Forms the Cartesian equation for their resulting vector.

A1: Correct answer (oe - e.g. $6x+24=3y-12=-2z$).