Question	Scheme	Marks	AOs
3(a)	$\begin{vmatrix} 3 & 2 & 1 \\ 2 & 3 & -1 \\ 1 & k & 2 \end{vmatrix} = 3(3\times 2 - k\times -1) - 2(2\times 2 - 1\times -1) + 1(2\times k - 1\times 3)$	M1	1.1b
	$= 5k+5$	A1	1.1b
		(2)	
(b)	(i) $3x+2y+z=4$	B1	1.1b
	(ii) EITHER $y = 2-\lambda \Rightarrow \lambda = 2-y$ OR $\begin{pmatrix} a \\ b \\ c \end{pmatrix} \square \begin{pmatrix} 1 \\ -1 \\ -1 \end{pmatrix} = 0$ and $\begin{pmatrix} a \\ b \\ c \end{pmatrix} \square \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix} = 0 = 0 \Rightarrow \mathbf{n} = A\begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix}$	M1	1.1b
	EITHER $x = 1+(2-y)+\mu \Rightarrow z = 3-(2-y)+2(x-(2-y)-1)$ OR $d = A\begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix} \square \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} = 5A$	M1	1.1b
	$\Rightarrow 2x+3y-z=5$	A1	1.1b
		(4)	
(c)	The planes meet when all three equations are satisfied, so we can find where they meet by solving $\begin{pmatrix} 3 & 2 & 1 \\ 2 & 3 & -1 \\ 1 & k & 2 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 4 \\ 5 \\ -1 \end{pmatrix}$	B1	3.1a
	If the planes form a sheaf, then they must share a common line. But if $k \neq -1$ the determinant of the matrix is non-zero, so the equation has unique solution and hence the planes would meet in a single point. Therefore, we must have $k=-1$.	B1	2.3
		(4)	
			(8 marks)

Notes:

(a)

M1: Attempts determinant. Correct $()-()+()$ structure, but allow up to two slips in entries.

A1: Determinant is $5k+5$.

(b)(i)

B1: Correct equation. (Accept multiples.)

(ii)

M1: Eliminates λ or μ from Cartesian equations OR attempts to find a vector normal to both direction vectors using scalar product (or cross product may be used).

M1: Eliminates the other variable from their equations OR uses the scalar product with $\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ and their normal to find d.

A1: Correct equation. (Accept multiples.)

(c)

B1: Makes the link between the Cartesian equations and the matrix in (a).

B1: Identifies a sheaf cannot be formed if the solution is unique and so the matrix must be singular to form a sheaf, and hence $k = -1$.