Question	Scheme	Marks	AOs
7(a)	$\begin{pmatrix}-1\\2\\1\end{pmatrix}.\begin{pmatrix}2\\3\\-4\end{pmatrix}=-2+6-4=0$ and $\begin{pmatrix}2\\0\\1\end{pmatrix}.\begin{pmatrix}2\\3\\-4\end{pmatrix}=4+0-4=0$ Alt: $\begin{pmatrix}-1\\2\\1\end{pmatrix}\times\begin{pmatrix}2\\0\\1\end{pmatrix}=\begin{pmatrix}2\times1-1\times0\\-(-1\times1-1\times2)\\-1\times0-2\times2\end{pmatrix}=...$	M1	1.1b
	As 2**i** + 3**j** – 4**k** is perpendicular to both direction vectors (two non-parallel vectors) of *Π* then it must be perpendicular to *Π*	A1	2.2a
		(2)	
(b)	$\begin{pmatrix}x\\y\\z\end{pmatrix}.\begin{pmatrix}2\\3\\-4\end{pmatrix}=\begin{pmatrix}3\\3\\2\end{pmatrix}.\begin{pmatrix}2\\3\\-4\end{pmatrix}\Rightarrow...$	M1	1.1a
	$2x+3y-4z=7$	A1	2.2a
		(2)	
(c)	$\dfrac{\lvert 2(4+t)+3(-5+6t)-4(2-3t)-7\rvert}{\sqrt{2^2+3^2+(-4)^2}}=2\sqrt{29}\Rightarrow t=...$	M1	3.1a
	$t=-\dfrac{9}{8}$ and $t=\dfrac{5}{2}$	A1	1.1b
	$\boldsymbol{r}=\begin{pmatrix}4\\-5\\2\end{pmatrix}-\dfrac{9}{8}\begin{pmatrix}1\\6\\-3\end{pmatrix}=...$ or $\boldsymbol{r}=\begin{pmatrix}4\\-5\\2\end{pmatrix}+\dfrac{5}{2}\begin{pmatrix}1\\6\\-3\end{pmatrix}=...$	M1	1.1b
	$\left(\dfrac{23}{8},-\dfrac{47}{4},\dfrac{43}{8}\right)$ and $\left(\dfrac{13}{2},10,-\dfrac{11}{2}\right)$	A1	2.2a
		(4)	
			(8 marks)

Notes:

(a)
M1: Attempts the scalar product of each direction vector and the vector 2**i** + 3**j** – 4**k.** Some numerical calculation is required, just "= 0" is insufficient. Alternatively, attempts the cross product (allow sign slips) with the two direction vectors.
A1: Shows that both scalar products = 0 (minimum $-2+6-4=0$ and $4-4=0$) and makes a minimal conclusion with no erroneous statements. If using cross product, the calculation must be correct, and a minimal conclusion given with no erroneous statements.

(b)

M1: Applies $\begin{pmatrix} x \\ y \\ z \end{pmatrix} . \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix} = \begin{pmatrix} 3 \\ 3 \\ 2 \end{pmatrix} . \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix} \Rightarrow \ldots$

A1: $2x + 3y - 4z = 7$

(c)

M1: A fully correct method for finding a value of *t*. Other methods are possible, but must be valid and lead to a value of *t*. Examples of other methods:

- $2\sqrt{29} = \pm\left(\dfrac{2(4+t)+3(-5+6t)-4(2-3t)}{\sqrt{2^2+3^2+(-4)^2}} - \dfrac{7}{\sqrt{29}}\right)$ using plane parallel to Π through origin and shortest distance from plane to origin.
- $2(4+t)+3(-5+6t)-4(2-3t) = 7 \Rightarrow t = t_i$ (*t* at intersection of line and plane) and $\sin\theta = \dfrac{(2,3,-4)^T.(1,6,-3)^T}{\sqrt{29}\sqrt{46}}$ (sine of angle between line and plane) followed by $\sin\theta = \dfrac{2\sqrt{29}}{k\sqrt{46}} \Rightarrow k = \ldots \Rightarrow t = t_i \pm k$

A1: Correct values for *t*. Both are required.

M1: Uses a value of *t* to find a set of coordinates for *A*.

A1: Both correct sets of coordinates for *A*.