Question Number	Scheme	Notes	Marks
6(a)	$\pm\overrightarrow{AB} = \pm\left(\begin{pmatrix}-1\\1\\3\end{pmatrix} - \begin{pmatrix}3\\2\\2\end{pmatrix}\right) = \pm\begin{pmatrix}-4\\-1\\1\end{pmatrix}, \pm\overrightarrow{AC} = \pm\left(\begin{pmatrix}-2\\4\\2\end{pmatrix} - \begin{pmatrix}3\\2\\2\end{pmatrix}\right) = \pm\begin{pmatrix}-5\\2\\0\end{pmatrix}, \pm\overrightarrow{BC} = \pm\left(\begin{pmatrix}-2\\4\\2\end{pmatrix} - \begin{pmatrix}-1\\1\\3\end{pmatrix}\right) = \pm\begin{pmatrix}-1\\3\\-1\end{pmatrix}$ Correct method to obtain two relevant vectors using **subtraction**. You can ignore labelling e.g. if they find $\overrightarrow{BA}$ but call it $\overrightarrow{AB}$		M1
	e.g., $\overrightarrow{AB}\times\overrightarrow{AC} = \begin{pmatrix}-4\\-1\\1\end{pmatrix}\times\begin{pmatrix}-5\\2\\0\end{pmatrix} = \begin{pmatrix}-2\\-5\\-13\end{pmatrix}$ Correct method to find the vector product of two relevant vectors (if a correct method is not shown, two correct components for their vectors must be obtained)		**d**M1
	e.g., $\begin{pmatrix}3\\2\\2\end{pmatrix}.\begin{pmatrix}2\\5\\13\end{pmatrix} = 6+10+26 = 42$ Attempts the scalar product between their normal vector and any of the position vectors of *A*, *B* or *C*.		**dd**M1
	$2x + 5y + 13z = 42$ oe e.g. $-2x-5y-13z+42=0$	Any correct **Cartesian** equation.	A1
			(4)
(a) alt 1	$\pm\overrightarrow{AB} = \pm\left(\begin{pmatrix}-1\\1\\3\end{pmatrix} - \begin{pmatrix}3\\2\\2\end{pmatrix}\right) = \pm\begin{pmatrix}-4\\-1\\1\end{pmatrix}, \pm\overrightarrow{AC} = \pm\left(\begin{pmatrix}-2\\4\\2\end{pmatrix} - \begin{pmatrix}3\\2\\2\end{pmatrix}\right) = \pm\begin{pmatrix}-5\\2\\0\end{pmatrix}, \pm\overrightarrow{BC} = \pm\left(\begin{pmatrix}-2\\4\\2\end{pmatrix} - \begin{pmatrix}-1\\1\\3\end{pmatrix}\right) = \pm\begin{pmatrix}-1\\3\\-1\end{pmatrix}$ Correct method to obtain two relevant vectors using subtraction.		M1
	e.g., $\mathbf{r} = \begin{pmatrix}3\\2\\2\end{pmatrix} + \lambda\begin{pmatrix}-4\\-1\\1\end{pmatrix} + \mu\begin{pmatrix}-5\\2\\0\end{pmatrix} \Rightarrow \begin{matrix}x = 3-4\lambda-5\mu\\ y = 2-\lambda+2\mu\\ z = 2+\lambda\end{matrix} \Rightarrow \text{e.g. } \lambda = z-2$ Attempts the parametric equation of the plane and uses components to eliminate at least one of their parameters.		**d**M1
	$\begin{matrix}x = 3-4\lambda-5\mu\\ \text{e.g., } y = 2-\lambda+2\mu\\ z = 2+\lambda\end{matrix} \Rightarrow \text{e.g. } \lambda = z-2 \Rightarrow \text{e.g. } \mu = \frac{1}{2}(y-4+z)$ Eliminates both of their parameters.		**dd**M1
	e.g. $x = 3-4(z-2)-\frac{5}{2}(y-4+z)$	Any correct **Cartesian** equation.	A1
(a) alt 2	$\begin{matrix}3a+2b+2c=1\\ ax+by+cz=1 \rightarrow\ -a+b+3c=1\\ -2a+4b+2c=1\end{matrix} \Rightarrow a=\frac{1}{21},\ b=\frac{5}{42},\ c=\frac{13}{42}$ $\Rightarrow \frac{1}{21}x+\frac{5}{42}y+\frac{13}{42}z=1$ M1: Substitutes the given points to give 3 equations in 3 unknowns dM1: Solves simultaneously to find values for "*a*", "*b*" and "*c*" ddM1: Substitutes back in to obtain a Cartesian equation A1: Any correct equation		

(b)	Line DE : (**r** =) $\begin{pmatrix}-1\\1\\-2\end{pmatrix} \pm \lambda \begin{pmatrix}2\\5\\13\end{pmatrix}$	Obtains parametric form for line DE with their normal (or recalculated normal) seen or implied. Allow one slip only.	M1
	$14(2\lambda-1)-(5\lambda+1)-17(13\lambda-2)=-66 \Rightarrow \lambda=...$ Substitutes their parametric form into the equation of Π_2 and solves for λ – can follow M0 provided their parametric form was an attempt at $\overrightarrow{OD} \pm \lambda$(their **n**)		M1
	$\lambda = \frac{85}{198}$	A correct exact value for λ depending on their method e.g. use of $\mathbf{n} = -2\mathbf{i}-5\mathbf{j}-13\mathbf{k}$ gives $\lambda = -\frac{85}{198}$	A1
	$DE = \sqrt{(2\times\frac{85}{198})^2+(5\times\frac{85}{198})^2+(13\times\frac{85}{198})^2}$ or e.g. $E=\left(-\frac{14}{99},\frac{623}{198},\frac{709}{198}\right) \Rightarrow DE=\sqrt{\left(-1+\frac{14}{99}\right)^2+\left(1-\frac{623}{198}\right)^2+\left(-2-\frac{709}{198}\right)^2}$ Correct method to find a numerical expression for distance DE Requires previous method mark Note $DE=-\frac{85}{198}\sqrt{(2)^2+(5)^2+(13)^2}=...$ is ok for this mark		**d**M1
	$DE=\frac{85\sqrt{22}}{66}$	Correct exact answer in the required form or $p=\frac{85}{66}$ or $1\frac{19}{66}$ Not $DE=-\frac{85\sqrt{22}}{66}$	A1
			(5)

<u>Beware – Special Case!</u>

An incorrect sign of λ may fortuitously give the correct length DE.

E.g. $\begin{pmatrix}-1\\1\\-2\end{pmatrix}+\lambda\begin{pmatrix}2\\5\\13\end{pmatrix}$ leading incorrectly to $\lambda=-\frac{85}{198}$ would lead in both **d**M1 cases above to $DE=\frac{85\sqrt{22}}{66}$

E.g. $\begin{pmatrix}-1\\1\\-2\end{pmatrix}+\lambda\begin{pmatrix}-2\\-5\\-13\end{pmatrix}$ leading incorrectly to $\lambda=\frac{85}{198}$ would lead in both **d**M1 cases above to $DE=\frac{85\sqrt{22}}{66}$

In such cases score as M1M1A0M1A1ft i.e. we will only penalise it once.

Way 2 **Sim. eqns**	$(\pm)\left(\frac{x+1}{2}=\frac{y-1}{5}=\frac{z+2}{13}\right)$ $\Rightarrow y=\frac{5}{2}x+\frac{7}{2},\ z=\frac{13}{2}x+\frac{9}{2}$	Obtains Cartesian form for line *DE* with their normal (or recalculated normal) allowing one slip only **and** attempts to find two variables in terms of the other variable	M1
For first three marks	$14x-\left(\frac{5}{2}x+\frac{7}{2}\right)-17\left(\frac{13}{2}x+\frac{9}{2}\right)=-66$ $\Rightarrow\ x=-\frac{14}{99},\ y=\frac{623}{198},\ z=\frac{709}{198}$	M1: Substitutes into the plane equation and finds $x=...$, $y=...$, $z=...$ A1: Correct exact values $\Longrightarrow$ **Way 1** for last two marks	M1 A1
(c)	e.g. $\overrightarrow{AF}.\overrightarrow{AB}\times\overrightarrow{AC}=\begin{pmatrix}1\\1\\q-2\end{pmatrix}.\begin{pmatrix}2\\5\\13\end{pmatrix}=2+5+13q-26$ or e.g. $\begin{vmatrix}-4&-1&1\\-5&2&0\\1&1&q-2\end{vmatrix}=-4\big(2(q-2)\big)-5(q-2)-5-2$ or e.g. rule of Sarrus: $\begin{vmatrix}-4&-1&1&-4&-1\\-5&2&0&-5&2\\1&1&q-2&1&1\end{vmatrix}=-4\big(2(q-2)\big)-5-5(q-2)-2$ Correct method for vector between *F* and *A*, *B* or *C* and finds scalar product with their normal or attempts the scalar triple product to obtain a linear expression in *q*. For the scalar triple product look for at least 2 correct "elements".		M1
	$\frac{1}{6}(13q-19)=\pm12\Rightarrow q=...$ Sets $\frac{1}{6}$ of their expression in *q* equal to one or both of ±12 (or equivalent work e.g. their expression in *q* equal to one or both of ±72) and proceeds to a value for *q*		**d**M1
	$q=7,-\frac{53}{13}$	Correct values. Allow exact equivalents for $-\frac{53}{13}$ e.g. $-4\frac{1}{13}$	A1
			(3)
			Total 12