Question	Scheme	Marks
6(a)	$\begin{pmatrix}2\\0\\7\end{pmatrix}\times\begin{pmatrix}3\\-2\\3\end{pmatrix}=\begin{pmatrix}0-(-14)\\-(6-21)\\-4-0\end{pmatrix};=\begin{pmatrix}14\\15\\-4\end{pmatrix}$	**M1; A1**
		(2)
(b)	Direction of l is $\pm\left(\begin{pmatrix}1\\7\\3\end{pmatrix}-\begin{pmatrix}-1\\5\\2\end{pmatrix}\right)=\pm\begin{pmatrix}2\\2\\1\end{pmatrix}$	**B1**
	Angle between line and normal to plane is given by $\left(\cos\beta=\right)\dfrac{14\times2+15\times2-4\times1}{\sqrt{437}\sqrt{9}}\left(=\dfrac{18}{\sqrt{437}}\right)$	**M1**
	So angle between plane and line is $\alpha=90°-\beta=...$	**M1**
	$=59^{o}$	**A1**
		(4)
(c)	$\left\{\text{Equation of plane is } \mathbf{r}.\begin{pmatrix}14\\15\\-4\end{pmatrix}=\right\}\ \begin{pmatrix}-1\\5\\2\end{pmatrix}.\begin{pmatrix}14\\15\\-4\end{pmatrix}=53$	**M1 A1**
	So perpendicular distance is $\dfrac{\lvert14\times1+15\times7-4\times3-53\rvert}{\sqrt{437}}$	**M1**
	$=\dfrac{54}{\sqrt{437}}$	**A1**
		(4)
		(10 marks)

Notes

(a)

M1: Attempts the vector product of the two directions of the plane. If no method shown, at least two correct coordinates implies the method. Alternatively, sets up and solves a pair of simultaneous equations using dot products of a general vector with the directions. E.g.

$$\left.\begin{array}{l}(a\mathbf{i}+b\mathbf{j}+c\mathbf{k})\cdot(2\mathbf{i}+7\mathbf{k})=0\\(a\mathbf{i}+b\mathbf{j}+c\mathbf{k})\cdot(3\mathbf{i}-2\mathbf{j}+3\mathbf{k})=0\end{array}\right\}\Rightarrow\begin{array}{l}2a+7c=0\\3a-2b+3c=0\end{array}\Rightarrow a=..c,b=..c$$

A1: Correct normal to the plane.

(b)

B1: Correct direction vector for l, either direction.

M1: Attempts a relevant dot product of the direction of l and normal to the plane. If no method shown the value given must be correct for their vectors. Need not be named correctly, so accept if they think the angle between these is what they need for this mark.

M1: Correct method to find the required angle. Must be using the correct vectors, but may be scored if the previous M is withheld for incorrect method for the scalar product if they have stated this is what they were attempting to find. Look for use of cos β and subtracting from 90º, or for use of sin α with the dot product.

A1: Correct final angle (awrt). You may isw incorrect subsequent rounding following a correct answer.

(c)

M1: Attempts to find "$\pm d$" for the equation of the plane with their normal from (a) and the point B.

A1: Correct value or equation for plane.

M1: Attempts the perpendicular distance formula or any other full method for the distance, allowing minor slips (e.g. confusion in sign of d). E.g. $\dfrac{\left|\overrightarrow{OA}\cdot\mathbf{n}-\overrightarrow{OB}\cdot\mathbf{n}\right|}{\left|\mathbf{n}\right|}=\ldots$ is an equivalent method.

A1: Correct answer.

Alt (c)	$\left\|AB\right\|=\left\|\begin{pmatrix}2\\2\\1\end{pmatrix}\right\|=\sqrt{4+4+1}=3$	**M1 A1**
	So perpendicular distance is $\left\|AB\right\|\sin\alpha=\left\|AB\right\|\cos(90-\alpha)=\left\|AB\right\|\cos\beta=3\times"\dfrac{18}{\sqrt{437}}"$	**M1**
	$=\dfrac{54}{\sqrt{437}}$	**A1**
		(4)

M1: Correct method for the distance AB

A1: Correct AB.

M1: Attempts correct trig ratio with the exact answer for the relevant cosine from part (b).

A1: Correct answer.

Alt 2 (c)	$\hat{\mathbf{n}}=\dfrac{\mathbf{n}}{\left\|\mathbf{n}\right\|}=\dfrac{14\mathbf{i}+15\mathbf{j}-4\mathbf{k}}{\sqrt{437}}$ or $\overrightarrow{AB}\cdot\mathbf{n}=(2\mathbf{i}+2\mathbf{j}+\mathbf{k})(14\mathbf{i}+15\mathbf{j}-4\mathbf{k})=54$	**M1 A1**
	So perpendicular distance is $\left\|\overrightarrow{AB}\cdot\hat{\mathbf{n}}\right\|=\left\|\dfrac{(2\mathbf{i}+2\mathbf{j}+\mathbf{k})(14\mathbf{i}+15\mathbf{j}-4\mathbf{k})}{\sqrt{437}}\right\|=\ldots$	**M1**
	$=\dfrac{54}{\sqrt{437}}$	**A1**
		(4)

M1: Attempts the unit normal vector or correct attempt at $\overrightarrow{AB}\cdot\mathbf{n}$.

A1: Correct vector or correct value

M1: Applies formula for distance between planes.

A1: Correct answer.

Alt 3 (c)	$\left\{\text{Equation of plane is } \mathbf{r}.\begin{pmatrix}14\\15\\-4\end{pmatrix}=\right\}\ \begin{pmatrix}-1\\5\\2\end{pmatrix}.\begin{pmatrix}14\\15\\-4\end{pmatrix}=53$	**M1** **A1**
	Let X be where shortest distance to plane occurs. Then $\overrightarrow{AX}=\mathbf{i}+7\mathbf{j}+3\mathbf{k}-t\left(14\mathbf{i}+15\mathbf{j}-4\mathbf{k}\right)$ So X is where $\left((1+14t)\mathbf{i}+(7+15t)\mathbf{j}+(3-4t)\mathbf{k}\right)\square\left(14\mathbf{i}+15\mathbf{j}-4\mathbf{k}\right)=53$ $\Rightarrow 437t+107=53\Rightarrow t=-\frac{54}{437}$ $\overrightarrow{AX}=-\frac{54}{437}\left(14\mathbf{i}+15\mathbf{j}-4\mathbf{k}\right)\Rightarrow\left\lvert\overrightarrow{AX}\right\rvert=\frac{54}{437}\times\sqrt{437}=\ldots$	**M1**
	$=\frac{54}{\sqrt{437}}$	**A1**
		(4)

M1: Attempts to find "d" for the equation of the plane with their normal from (a) and the point B.

A1: Correct value / equation of plane implied.

M1: Sets up equation for line through A and perpendicular to the plane and forms and solves with the equation of the plane to find the parameter for which this line intersects the plane and attempts the length of AX.

A1: Correct answer.