Question	Scheme	Marks
4(a)	$\mathbf{b}\times\mathbf{c}=(\mathbf{i}+2\mathbf{j}-2\mathbf{k})\times(3\mathbf{i}+\mathbf{j}+\mathbf{k})=\begin{vmatrix}\mathbf{i}&\mathbf{j}&\mathbf{k}\\1&2&-2\\3&1&1\end{vmatrix}$ $=(2\times1-1\times-2)\mathbf{i}\pm(1\times1-3\times-2)\mathbf{j}+(1\times1-3\times2)\mathbf{k}$	**M1**
	$\mathbf{b}\times\mathbf{c}=4\mathbf{i}-7\mathbf{j}-5\mathbf{k}$	**A1**
		(2)
(b)	$\mathbf{a}\bullet(\mathbf{b}\times\mathbf{c})=(2\mathbf{i}-\mathbf{k})\bullet(4\mathbf{i}-7\mathbf{j}-5\mathbf{k})=2\times4+0\times-7+(-1)\times(-5)=...$	**M1**
	$=13$	**A1**
		(2)
(c)	Volume $OABC=\frac{1}{6}\lvert\mathbf{a}\bullet(\mathbf{b}\times\mathbf{c})\rvert=\frac{13}{6}$	**B1ft**
		(1)
(d) **Way 1**	Area triangle $OBC=\frac{1}{2}\lvert\mathbf{b}\times\mathbf{c}\rvert=\frac{1}{2}\sqrt{4^2+7^2+5^2}=...$	**M1**
	Vol $OABC=\frac{1}{3}h\times$ Area $OBC\Rightarrow\frac{1}{3}h\times"\frac{1}{2}\sqrt{90}"=\frac{13}{6}\Rightarrow h=...$	**M1**
	$=\frac{13}{3\sqrt{10}}$ or $\frac{13\sqrt{10}}{30}$	**A1**
		(3)
Way 2	Plane OBC is $\mathbf{r}\bullet"4\mathbf{i}-7\mathbf{j}-5\mathbf{k}"=0$ (using the origin as a point on the plane)	**M1**
	$d=\frac{\lvert4\times2-7\times0-5\times-1+0\rvert}{\sqrt{4^2+7^2+5^2}}=...$ oe	**M1**
	$=\frac{13}{3\sqrt{10}}$ or $\frac{13\sqrt{10}}{30}$	**A1**
		(3)
Way 3	Finding e.g. $\pm(\mathbf{c}-\mathbf{a})$ or $\pm(\mathbf{b}-\mathbf{a})$	**M1**
	Resolving along the direction of the normal e.g. $d=\left\lvert\frac{\pm(\mathbf{c}-\mathbf{a})\bullet\begin{pmatrix}4\\-7\\-5\end{pmatrix}}{\sqrt{4^2+7^2+5^2}}\right\rvert$ or $d=\left\lvert\frac{\pm(\mathbf{b}-\mathbf{a})\bullet\begin{pmatrix}4\\-7\\-5\end{pmatrix}}{\sqrt{4^2+7^2+5^2}}\right\rvert$	**M1**
	$=\frac{13}{3\sqrt{10}}$ or $\frac{13\sqrt{10}}{30}$	**A1**

		(3)

(8 marks)

Notes:

Accept equivalent vector notation, e.g. column vectors, throughout.

(a)

M1: Attempts the vector product with at least two components correct (simplified or unsimplified).

A1: Correct vector

(b)

M1: Takes the scalar product of **a** with their answer to (a). Obtaining a vector is M0.

A1: Correct value.

(c)

B1ft: For $\frac{1}{6}\times$ |their answer to (b)|

(d)

Way 1

M1: Correct method for the area of the triangle *OBC*.

M1: Sets up and solves a correct equation for the shortest distance using the formula $V=\frac{1}{3}A_b h$ with their area and their volume from (c).

A1: Correct answer. Accept equivalents such as $\frac{13}{\sqrt{90}}$ or $\frac{13\sqrt{90}}{90}$

Way 2

M1: Identifies or implies the equation of the plane containing *OBC* (following their (a)).

M1: Uses the perpendicular distance formula with their plane and point *A*.

A1: Correct answer. Accept equivalents such as $\frac{13}{\sqrt{90}}$ or $\frac{13\sqrt{90}}{90}$

Way 3

M1: Finds the directional vector $\pm(\mathbf{c}-\mathbf{a})$ or $\pm(\mathbf{b}-\mathbf{a})$

M1: Resolves along the direction of the normal vector to the plane

A1: Correct answer. Accept equivalents such as $\frac{13}{\sqrt{90}}$ or $\frac{13\sqrt{90}}{90}$