Question	Scheme	Marks	AOs
6(a)	Any two of: $\begin{cases} \pm k\,\overrightarrow{AB} = \pm k\left(5\mathbf{i}+25\mathbf{j}+5\mathbf{k}\right), \\ \pm k\,\overrightarrow{AC} = \pm k\left(-15\mathbf{i}+15\mathbf{j}-10\mathbf{k}\right), \\ \pm k\,\overrightarrow{BC} = \pm k\left(-20\mathbf{i}-10\mathbf{j}-15\mathbf{k}\right) \end{cases}$	M1	3.3
	Let normal vector be $a\mathbf{i}+b\mathbf{j}+c\mathbf{k}$ $\left(a\mathbf{i}+b\mathbf{j}+c\mathbf{k}\right)\bullet\left(\mathbf{i}+5\mathbf{j}+\mathbf{k}\right)=0,\ \left(a\mathbf{i}+b\mathbf{j}+c\mathbf{k}\right)\bullet\left(-3\mathbf{i}+3\mathbf{j}-2\mathbf{k}\right)=0$ $\Rightarrow a+5b+c=0,\ -3a+3b-2c=0 \Rightarrow a=...,\ b=...,\ c=...$ Alternative: cross product $\begin{vmatrix} 1 & 5 & 1 \\ -3 & 3 & -2 \end{vmatrix} = \left(-10-3\right)\mathbf{i}-\left(-2+3\right)\mathbf{j}+\left(3+15\right)\mathbf{k}$	M1	1.1b
	$\mathbf{n}=k\left(-13\mathbf{i}-\mathbf{j}+18\mathbf{k}\right)$	A1	1.1b
	$\left(-13\mathbf{i}-\mathbf{j}+18\mathbf{k}\right)\bullet\left(10\mathbf{i}+5\mathbf{j}-50\mathbf{k}\right)=...$	M1	1.1b
	$\mathbf{r}\bullet\left(13\mathbf{i}+\mathbf{j}-18\mathbf{k}\right)=1035$ o.e. $\mathbf{r}\bullet\left(-13\mathbf{i}-\mathbf{j}+18\mathbf{k}\right)=-1035$ $\mathbf{r}\bullet\left(325\mathbf{i}+25\mathbf{j}-450\mathbf{k}\right)=25875$	A1	2.5
		(5)	
(b)	Attempts the scalar product between their normal vector and the vector $\mathbf{k}$ and uses trigonometry to find an angle	M1	3.1b
	$\left(-13\mathbf{i}-\mathbf{j}+18\mathbf{k}\right)\bullet\mathbf{k}=-18=\sqrt{13^2+1^2+18^2}\,\cos\alpha$	M1	1.1b
	$\cos\alpha=\dfrac{-18}{\sqrt{494}}\Rightarrow\alpha=144.08...\Rightarrow\theta=36°$	A1	3.2a
		(3)	
(c)	Distance required is $\left|\lambda\right|$ where $\begin{pmatrix} 13 \\ 1 \\ -18 \end{pmatrix}\bullet\begin{pmatrix} 5 \\ 12 \\ \lambda \end{pmatrix}=1035$	M1	3.4
	$\left|\lambda\right|=53.2\text{m}$	A1	1.1b
		(2)	
(d)	E.g. • The mineral layer will **not** be perfectly **flat/smooth** and will not form a plane • The mineral layer will have a **depth** and this should be taken into account	B1	3.5b

		(1)	
		(11 marks)	

Notes

(a)

M1: Attempts to find at least 2 vectors in the plane that can be used to set up the model. Two correct value implies the correct method if not explicitly seen.

M1: Attempts a normal vector using an appropriate method. E.g. as in main scheme or may use vector product

A1: A correct normal vector

M1: Applies **r.n** = *d* with their normal vector and a point in the plane to find a value for *d*

A1: Correct equation (allow any multiple)

(b)

M1: Realises the scalar product between their from part (a) and a vector parallel to **k** and so applies it and uses trigonometry to find an angle

M1: Forms the scalar product between their from part (a) and a vector parallel to **k**

A1: Correct angle

(c)

M1: Uses the model and a correct strategy to establish the distance from (5, 12, 0) to the plane vertically downwards

A1: Correct distance

(d)

B1: Any reasonable limitation – see scheme