Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1	States or implies $x = 3 - \lambda$, $y = -5 + 2\lambda$ and $z = 3 - 3\lambda$	**M1**	1.1b	TBC
	Writes $\left(3-\lambda-(-2)\right)^2 + \left(-5+2\lambda-(-2)\right)^2 + \left(3-3\lambda-2\right)^2 = \left(7\sqrt{3}\right)^2$	**M1**	2.2a	
	Simplfies to obtain $14\lambda^2 - 28\lambda + 35 = 147$	**M1**	1.1b	
	Reduces and factorises: $\lambda^2 - 2\lambda - 8 = 0 \Rightarrow (\lambda - 4)(\lambda + 2) = 0$	**M1**	1.1b	
	Finds $\lambda = -2$ and states $A(5,-9,9)$	**A1**	1.1b	
	Finds $\lambda = 4$ and states $B(-1,3,-9)$	**A1**	1.1b	
		(6)		
				(6 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
2	Demonstrates an understanding of perpendicular vectors For example, states $\mathbf{a}\bullet\begin{pmatrix}x\\y\\z\end{pmatrix}=0$ or $\mathbf{b}\bullet\begin{pmatrix}x\\y\\z\end{pmatrix}=0$, or states scalar product is zero	**M1**	3.1a	TBC
	Writes two vector equations, $3x+y-z=0$ and $-x+5y+3z=0$	**M1**	1.1b	
	Makes an attempt to solve these equtions by setting either *x*, *y* or *z* equal to a constant, most likely 1	**M1**	2.2a	
	Solves to find *x*, *y* or *z* and states the solution: $(1,-1,2)$ or a multiple thereof	**A1**	1.1b	
		(4)		
				(4 marks)

Notes

Some may use cross or vector product to do this question.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3	Finds any two vectors For example, $\overrightarrow{AB}=\begin{pmatrix}-4\\11\\-4\end{pmatrix}$ and $\overrightarrow{AC}=\begin{pmatrix}5\\4\\-11\end{pmatrix}$	**M1**	3.1a	TBC
	Finds the scalar product of these two vectors, $\overrightarrow{AB}\bullet\overrightarrow{AC}=\begin{pmatrix}-4\\11\\-4\end{pmatrix}\bullet\begin{pmatrix}5\\4\\-11\end{pmatrix}=-20+44+44=68$	**M1**	1.1b	
	Finds the magnitude of each vector, $\lvert\overrightarrow{AB}\rvert=\sqrt{(-4)^2+(11)^2+(-4)^2}=\sqrt{153}$ and $\lvert\overrightarrow{AC}\rvert=\sqrt{(5)^2+(4)^2+(-11)^2}=\sqrt{162}$	**M1**	1.1b	
	Uses $\cos(\angle BAC)=\dfrac{\overrightarrow{AB}\bullet\overrightarrow{AC}}{\lvert\overrightarrow{AB}\rvert\lvert\overrightarrow{AC}\rvert}=\dfrac{68}{\sqrt{153}\sqrt{162}}$ to find $\cos(\angle BAC)=0.4319...$ and therefore $\angle BAC=64.410...$	**A1**	2.2a	
	States area = $\frac{1}{2}\lvert\overrightarrow{AB}\rvert\lvert\overrightarrow{AC}\rvert\sin(\angle BAC)$ or writes, area = $\frac{1}{2}\sqrt{153}\sqrt{162}\sin(64.41...)$	**M1**	2.2a	
	States correct answer = 71.0, accept awrt 71.0	**A1**	1.1b	
		(6)		
				(6 marks)

Notes

Some may use vector product

The triangle area is $\frac{1}{2}\lvert\overrightarrow{AB}\times\overrightarrow{AC}\rvert$

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
4a	Demonstrates an understanding of perpendicular vectors by writing, $\begin{pmatrix}3\\-4\\-2\end{pmatrix}\bullet\begin{pmatrix}2p\\1\\p\end{pmatrix}=0$	**M1**	3.1a	TBC
	Solves $6p-4-2p=0$ writing $p=1$	**A1**	1.1b	
		(2)		
4b	Writes any two of the following by equating *x*, *y* and *z* compnents, $1+3\lambda=-16+2\mu$, $-3-4\lambda=5+\mu$ or $1-2\lambda=3+\mu$	**M1**	3.1a	
	Solves any pair of simultaneous equations to find, $\lambda=-3$ and $\mu=4$	**M1**	1.1b	
	Checks that $\lambda=-3$ and $\mu=4$ satisfies the third equation	**M1**	2.3	
	States the correct point of intersection, $(-8,9,7)$	**A1**	1.1b	
		(4)		
				(6 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
5	States that a general point on l_1 has position vector $\begin{pmatrix}6+4\lambda\\2+5\lambda\\-2-\lambda\end{pmatrix}$	**M1**	1.1b	TBC
	Makes an attempt to substitute $\begin{pmatrix}6+4\lambda\\2+5\lambda\\-2-\lambda\end{pmatrix}$ into $2x-y+4z=4$ For example, $2(6+4\lambda)-(2+5\lambda)+4(-2-\lambda)=4$ is seen	**M1**	3.1a	
	Solves the equation to find $\lambda=-2$ and concludes that the point of intersection is $(-2,-8,0)$	**M1**	1.1b	
	States that a vector equation of the line through $(6,2,-2)$ and perpendicular to Π is $\mathbf{r}=\begin{pmatrix}6\\2\\-2\end{pmatrix}+\mu\begin{pmatrix}2\\-1\\4\end{pmatrix}$	**M1**	3.1a	
	Attempts to finds a point on this line that is also on Π by substituting, $x=6+2\mu$, $y=2-\mu$ and $z=-2+4\mu$ into $2x-y+4z=4$	**M1**	3.1a	
	Solves $2(6+2\mu)-(2-\mu)+4(-2+4\mu)=4$ to obtain $\mu=\frac{2}{21}$	**A1**	1.1b	
	Concludes that the point, $\begin{pmatrix}6\\2\\-2\end{pmatrix}+\frac{2}{21}\begin{pmatrix}2\\-1\\4\end{pmatrix}$ is halfway between $(6,2,-2)$ and a point on l_2; therefore, a point on l_2 has position vector, $\begin{pmatrix}6\\2\\-2\end{pmatrix}+\frac{4}{21}\begin{pmatrix}2\\-1\\4\end{pmatrix}=\begin{pmatrix}\frac{134}{21}\\\frac{24}{21}\\-\frac{12}{21}\end{pmatrix}$ (continued)	**M1**	3.2a	

	Attempts to find the equation of l_2 using the points $\begin{pmatrix} -2 \\ -8 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} \frac{134}{21} \\ \frac{24}{21} \\ -\frac{12}{21} \end{pmatrix}$	**M1**	1.1b	
	Finds a correct vector equation of l_2 : $r = \begin{pmatrix} -2 \\ 8 \\ 0 \end{pmatrix} + v\begin{pmatrix} 44 \\ 48 \\ -3 \end{pmatrix}$ Accept $\begin{pmatrix} \frac{134}{21} \\ \frac{24}{21} \\ -\frac{12}{21} \end{pmatrix}$ instead of $\begin{pmatrix} -2 \\ -8 \\ 0 \end{pmatrix}$ and any multiple of $\begin{pmatrix} 44 \\ 48 \\ -3 \end{pmatrix}$	**A1**	1.1b	
		(9)		
				(9 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
6a	Finds two vectors in the plane, for example $\overrightarrow{PQ}=(-5,1,-5)$ and $\overrightarrow{PR}=(3,3,-6)$	**M1**	3.1a	TBC
	Uses the dot product to find two vector equations, $-5x+y-5z=0$ and $3x+3y-6z=0$	**M1**	1.1b	
	Makes an attempt to solve these equtions by setting either *x*, *y* or *z* equal to a constant, most likely 1	**M1**	2.2a	
	Solves to find *x*, *y* or *z* and states the solution for a vector normal to the plane, $\left(-\frac{1}{2}\mathbf{i}+\frac{5}{2}\mathbf{j}+\mathbf{k}\right)$ or $(-\mathbf{i}+5\mathbf{j}+2\mathbf{k})$ or a muiplte thereof	**A1**	2.2a	
	Finds a unit vector normal to the plane using Pythagoras' Theorem in three dimensions, $\frac{1}{\sqrt{30}}(-\mathbf{i}+5\mathbf{j}+2\mathbf{k})$	**A1**	1.1b	
		(5)		
6b	Uses the fact that a general vector on the plane $(x-2, y-1, z-5)$ will be perpendicular to the normal vector $(-1,5,1)$ by writing $\begin{pmatrix}x-2\\y-1\\z-5\end{pmatrix}\cdot\begin{pmatrix}-1\\5\\1\end{pmatrix}=0$	**M1**	3.1a	TBC
	Solves to find: $-x+5y+z=8$	**A1**	1.1b	
		(2)		

6c	States $n_1 = (-1, 5, 2)$ and $n_2 = (3, 2, -8)$ and finds the scalar product of these two vectors, $n_1 \bullet n_2 = \begin{pmatrix}-1\\5\\2\end{pmatrix} \bullet \begin{pmatrix}3\\2\\-8\end{pmatrix} = -3+10-16=-9$	**M1**	1.1b	TBC
	Finds the magnitude of each vector, $\lvert n_1 \rvert = \sqrt{(-1)^2+(5)^2+(2)^2} = \sqrt{30}$ and $\lvert n_2 \rvert = \sqrt{(3)^2+(2)^2+(-8)^2} = \sqrt{77}$	**M1**	1.1b	
	Uses $\cos\theta = \dfrac{n_1 \bullet n_2}{\lvert n_1 \rvert \lvert n_1 \rvert} = \dfrac{-9}{\sqrt{30}\sqrt{77}}$ to find $\cos\theta = -0.18725...$ and finds $\theta = 100.79.27...^\circ$	**M1**	2.2a	
	States the acute angle between the planes is 79.2°	**A1**	1.1b	
		(4)		
				(11 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
7a	Finds $\overrightarrow{PQ} = (6, -13, 14)$	M1	3.1a	TBC
	States that a general point, S, on $\overrightarrow{PQ}$ is $S = \begin{pmatrix} 6 \\ -13 \\ 14 \end{pmatrix} + \lambda \begin{pmatrix} 10 \\ 4 \\ -2 \end{pmatrix}$	M1	1.1b	
	At the shortest (perpendicular) distance $\begin{pmatrix} 6+10\lambda \\ -13+4\lambda \\ 14-2\lambda \end{pmatrix} \bullet \begin{pmatrix} 10 \\ 4 \\ -2 \end{pmatrix} = 0$	M1	1.1b	
	Solves $60 + 100\lambda - 52 + 16\lambda - 28 + 4\lambda = 0$ to obtain $\lambda = \frac{1}{6}$	A1	1.1b	
	Substitutes λ to find the coordinates of S: $S\begin{pmatrix} \frac{23}{3} \\ -\frac{37}{3} \\ \frac{41}{3} \end{pmatrix}$ and attempts to find the distance $OS = \sqrt{\left(\frac{23}{3}\right)^2 + \left(-\frac{37}{3}\right)^2 + \left(\frac{41}{3}\right)^2}$	M1	3.1a	
	Finds minimum distance = $\sqrt{\frac{1193}{3}} \approx 19.9$ km	A1	1.1b	
	Concludes that as this is greater than 15 km, so submarine A can move undetected.	A1 ft	3.2a	
		(7)		
7b	Possible answers, Sub A will not move in an exact straight line Sub A might purposely deviate to avoid detection Sub A might not be able to move in a straight line due to rocks Sub B will not be stationary	B1	3.5b	
		(1)		
				(8 marks)

Notes