1. $\vec{AB} = \begin{pmatrix}3\\8\\1\end{pmatrix} - \begin{pmatrix}1\\2\\3\end{pmatrix} = \begin{pmatrix}3\\-6\\-2\end{pmatrix}$ B1

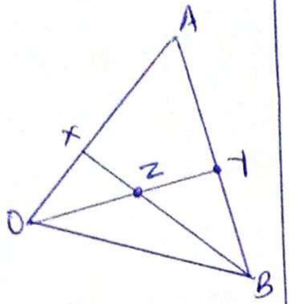
$\vec{BC} = \begin{pmatrix}7\\20\\-3\end{pmatrix} - \begin{pmatrix}3\\8\\1\end{pmatrix} = \begin{pmatrix}4\\-12\\-4\end{pmatrix}$ B1

direction ratios of $\vec{AB} = 3:-6:-2 = 1:-3:-1$ B1

direction ratios of $\vec{BC} = 4:-12:-4 = 1:-3:-1$ B1

Since $\vec{AB}$ and $\vec{BC}$ have the same direction ratios and contain a common point B, A, B and C are collinear. B1 (05)

2. $\vec{OZ} = \lambda \vec{OY}$



$\vec{OY} = \vec{OA} + \frac{1}{2}\vec{AB}$

$= \underset{\sim}{a} + \frac{1}{2}(\underset{\sim}{b} - \underset{\sim}{a})$

$= \frac{1}{2}(\underset{\sim}{a} + \underset{\sim}{b})$

$\vec{OZ} = \frac{\lambda}{2}(\underset{\sim}{a} + \underset{\sim}{b})$ --- ① B1

$\vec{OZ} = \vec{OX} + \mu\vec{XB}$

$= \frac{1}{2}\underset{\sim}{a} + \mu(\underset{\sim}{b} - \frac{1}{2}\underset{\sim}{a})$

$\vec{OZ} = \frac{1}{2}(\underset{\sim}{a} + 2\mu\underset{\sim}{b} - \mu\underset{\sim}{a})$ -- ① B1

Equating components: (05)

$\underset{\sim}{a}$: $\lambda = 1 - \mu$

$\underset{\sim}{b}$: $\lambda = 2\mu$

$1 - 3\mu = 0$ M1 $\Rightarrow \mu = \frac{1}{3} \Rightarrow \lambda = \frac{2}{3}$ A1

$\therefore \vec{OZ} = \frac{1}{3}(\underset{\sim}{a} + \underset{\sim}{b})$ B1

3. $\underset{\sim}{d_1} = \begin{pmatrix}4\\6\\-2\end{pmatrix}$, $\underset{\sim}{d_2} = \begin{pmatrix}0\\1\\0\end{pmatrix}$ B1

$\underset{\sim}{d_1}\cdot\underset{\sim}{d_2} = |\underset{\sim}{d_1}||\underset{\sim}{d_2}|\cos\theta$

$\begin{pmatrix}4\\6\\-2\end{pmatrix}\cdot\begin{pmatrix}0\\1\\0\end{pmatrix}$ M1 $= \sqrt{(4)^2+(6)^2+(-2)^2}\sqrt{0^2+(1)^2+0^2}\cos\theta$ M1

$6 = \sqrt{56}\cos\theta$ M1

$\theta = \cos^{-1}(6/\sqrt{56}) = 36.7°$ A1 (05)

direction ratios $= 4:6:-2$ B1
$= 2:3:-1$

4. Suppose the lines intersect

$\underset{\sim}{r_1} = \underset{\sim}{r_2}$

$\begin{pmatrix}17+2\alpha\\2-3\alpha\\-6+9\alpha\end{pmatrix} = \begin{pmatrix}2+6\beta\\-3+7\beta\\4-\beta\end{pmatrix}$

$6\beta - 2\alpha = 15$

$7\beta + 3\alpha = 5$ M1 $\Rightarrow$ $3|\ 7\beta + 3\alpha = 5$; $1|\ \beta + 9\alpha = 10$

$\beta + 9\alpha = 10$

$21\beta + 9\alpha = 15$

$-\ \beta + 9\alpha = 10$

$20\beta = 5$ M1 $\Rightarrow \beta = 1/4$ A1 (05)

$9\alpha = 10 - 1/4 \Rightarrow 9\alpha = \frac{39}{4} \Rightarrow \alpha = \frac{12}{13}$ A1

$6\beta - 2\alpha = \frac{3}{2} - 2\left(\frac{12}{13}\right) \neq 15$

Since α and β are inconsistent, the lines don't intersect hence are skew. B1

5. $\vec{PQ} = \begin{pmatrix}1\\-2\\-1\end{pmatrix} - \begin{pmatrix}1\\1\\1\end{pmatrix} = \begin{pmatrix}0\\-3\\-2\end{pmatrix}$ B1

$\vec{PR} = \begin{pmatrix}3\\-1\\2\end{pmatrix} - \begin{pmatrix}1\\1\\1\end{pmatrix} = \begin{pmatrix}2\\-2\\1\end{pmatrix}$

$\underset{\sim}{n} = \vec{PQ} \wedge \vec{PR} = \begin{vmatrix} i & j & k \\ 0 & -3 & -2 \\ 2 & -2 & 1 \end{vmatrix}$ M1

$\underset{\sim}{n} = -7\underset{\sim}{i} - 4\underset{\sim}{j} + 6\underset{\sim}{k}$ A1

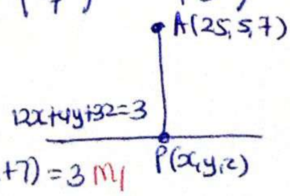
$\underset{\sim}{r}\cdot\underset{\sim}{n} = \underset{\sim}{a}\cdot\underset{\sim}{n}$ (05)

$\underset{\sim}{r}\cdot\begin{pmatrix}-7\\-4\\6\end{pmatrix} = \begin{pmatrix}1\\1\\1\end{pmatrix}\cdot\begin{pmatrix}-7\\-4\\6\end{pmatrix}$ M1

$\underset{\sim}{r}\cdot\begin{pmatrix}-7\\-4\\6\end{pmatrix} = -7-4+6$

$\therefore \underset{\sim}{r}\cdot\begin{pmatrix}-7\\-4\\6\end{pmatrix} = -5$ A1 is the vector product equation of the plane.

6. $\vec{AP} = \lambda\underset{\sim}{n} \Rightarrow \begin{pmatrix}x\\y\\z\end{pmatrix} - \begin{pmatrix}25\\5\\7\end{pmatrix} = \lambda\begin{pmatrix}12\\4\\3\end{pmatrix}$



$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}12\lambda+25\\4\lambda+5\\3\lambda+7\end{pmatrix}$ B1

$12(12\lambda+25) + 4(4\lambda+5) + 3(3\lambda+7) = 3$ M1

$144\lambda + 300 + 16\lambda + 20 + 9\lambda + 21 = 3$ (05)

$169\lambda = -338 \Rightarrow \lambda = -2$ A1

$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}12(-2)+25\\4(-2)+5\\3(-2)+7\end{pmatrix}$ M1 $= \begin{pmatrix}1\\-3\\1\end{pmatrix}$ B1

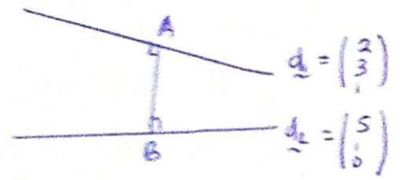
The foot of the perpendicular is $(1,-3,1)$ B1

$$d_1 = \frac{2(2)-3(2)+1-1}{\sqrt{(2)^2+(-3)^2+(1)^2}} \text{ M1} = \frac{-2}{\sqrt{14}} \text{ A1}$$

$$d_2 = \frac{2(1)-3(-2)+1-1}{\sqrt{(2)^2+(-2)^2+(1)^2}} \text{ M1} = \frac{8}{\sqrt{14}} \text{ A1} \qquad (05)$$

Since $d_1 d_2 < 0$, the points M and N lie on the opposite sides of the plane. B1

8



$A(1+2m, -1+3m, m)$ B1

$B(-1+5n, 1+n, 1)$

$$\vec{AB} = \vec{OB} - \vec{OA} = \begin{pmatrix}-1+5n\\1+n\\1\end{pmatrix} - \begin{pmatrix}1+2m\\-1+3m\\m\end{pmatrix} = \begin{pmatrix}5n-2m-2\\n-3m+2\\1-m\end{pmatrix}$$

$d_1 \cdot \vec{AB} = 0$ and $d_2 \cdot \vec{AB} = 0$

$$\begin{pmatrix}5n-2m-2\\n-3m+2\\1-m\end{pmatrix} \cdot \begin{pmatrix}2\\3\\1\end{pmatrix} = 0 \Rightarrow 13n-14m+3=0 \quad \text{--(1)}$$

$$\begin{pmatrix}5n-2m+2\\n-3m+2\\1-m\end{pmatrix} \cdot \begin{pmatrix}5\\1\\0\end{pmatrix} = 0 \Rightarrow 26n-13m-8=0 \quad \text{--(2)}$$

$26n - 28m = -6$ M1

$-26n - 13m = 8$

$-15m = -14 \Rightarrow m = \frac{14}{15}$ A1 (05)

$13n - \left(\frac{14 \times 14}{5}\right) = -3 \Rightarrow n = \frac{151}{195}$

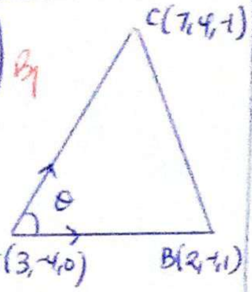
$$\vec{AB} = \begin{pmatrix}5\left(\frac{151}{195}\right) - 2\left(\frac{14}{15}\right) - 2\\ \frac{151}{195} - 3\left(\frac{14}{15}\right) + 2\\ 1 - \frac{14}{15}\end{pmatrix} = \begin{pmatrix}\frac{1}{195}\\ -\frac{1}{39}\\ \frac{1}{15}\end{pmatrix} \text{ B1}$$

$$|\vec{AB}| = \sqrt{\left(\frac{1}{195}\right)^2 + \left(\frac{-1}{39}\right)^2 + \left(\frac{1}{15}\right)^2}$$

$= 0.07161$ units B1

9 (a)

$$\vec{AB} = \begin{pmatrix}2\\-1\\1\end{pmatrix} - \begin{pmatrix}3\\-4\\0\end{pmatrix} = \begin{pmatrix}-1\\3\\1\end{pmatrix} \text{ B1}$$



$$\vec{AC} = \begin{pmatrix}7\\4\\-1\end{pmatrix} - \begin{pmatrix}3\\-4\\0\end{pmatrix} = \begin{pmatrix}4\\8\\-1\end{pmatrix} \text{ B1}$$

$\vec{AC} \cdot \vec{AB} = |\vec{AB}||\vec{AC}| \cos\theta$

$$\begin{pmatrix}-1\\3\\1\end{pmatrix} \cdot \begin{pmatrix}4\\8\\-1\end{pmatrix} = \sqrt{(-1)^2+(3)^2+(1)^2}\sqrt{(4)^2+(8)^2+(-1)^2} \cos\theta \text{ M1}$$

$-4+24-1 = \sqrt{11 \times 81} \cos\theta$ M1 (08)

$\cos\theta = \frac{19}{9\sqrt{11}}$

$\theta = \cos^{-1}\left(\frac{19}{9\sqrt{11}}\right) = 50.47°$ A1

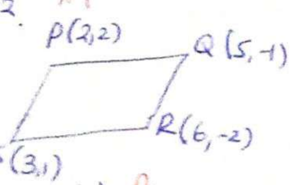
Since the angle is not 0° or 180°, A, B and C are vertices of a triangle. B1

$A = \frac{1}{2}|\vec{AB}||\vec{AC}| \sin\theta$

$= \frac{1}{2} \times 9\sqrt{11} \sin 50.47°$ M1

$= 11.5114$ units^2. A1

(b)



$\vec{PS} = \begin{pmatrix}1\\-1\end{pmatrix}$ B1 $\vec{QR} = \begin{pmatrix}1\\-1\end{pmatrix}$ B1

$\vec{PQ} = \begin{pmatrix}3\\-3\end{pmatrix} = 3\begin{pmatrix}1\\-1\end{pmatrix}$ $\vec{SR} = \begin{pmatrix}2\\-2\end{pmatrix} = 2\begin{pmatrix}1\\-1\end{pmatrix}$ B1

The points; P, Q, R and S lie on a straight and can not form a quadrilateral. B1 (04)

10 (a)

$$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}1+3\lambda\\-2+2\lambda\\1+5\lambda\end{pmatrix} \text{ B1}$$

$2x - y + 4z = 6$

$2(1+3\lambda) - (-2+2\lambda) + 4(1+5\lambda) = 32$ M1

$24\lambda = 24$

$\lambda = 1$ A1

$$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}1+3(1)\\-2+2(1)\\1+5(1)\end{pmatrix} \text{ M1} = \begin{pmatrix}4\\0\\6\end{pmatrix}$$

The point of intersection is $(4,0,6)$ A1

$n = \begin{pmatrix}2\\-1\\4\end{pmatrix}, \quad d = \begin{pmatrix}3\\2\\5\end{pmatrix}$

$n \cdot d = |n||d| \sin\theta$

$\begin{pmatrix}2\\-1\\4\end{pmatrix} \cdot \begin{pmatrix}3\\2\\5\end{pmatrix} = \sqrt{(2)^2+(-1)^2+(4)^2}\sqrt{(3)^2+(2)^2+(5)^2} \sin\theta$

$6-2+20 = \sqrt{21 \times 38} \sin\theta$

$\theta = \sin^{-1}\left(\frac{24}{\sqrt{21\times 38}}\right) = 58.17^\circ$

10 b) $2x-y+4z=32$ M1

$2(2)-(-2)+4(5) = 26 \neq 32$ M1

$2(1)-2+4(-1) = -4 \neq 32$ B1

04

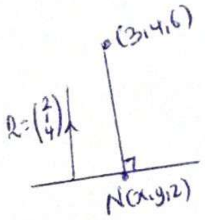
Both points don't lie on the line B1

11 (a) $\frac{x-2}{1} = \lambda \Rightarrow \frac{3-2}{1} = \lambda \Rightarrow \lambda = 1$ B1

$\frac{2-y}{-2} = -1 \Rightarrow y = 4$ B1

$\frac{z-3}{3} = 1 \Rightarrow z = 6$ B1

$\therefore P$ is $(3,4,6)$



$\overrightarrow{PN} = \lambda n$

$\begin{pmatrix}x\\y\\z\end{pmatrix} - \begin{pmatrix}3\\4\\6\end{pmatrix} = \lambda\begin{pmatrix}2\\1\\4\end{pmatrix}$

$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}3+2\lambda\\4+\lambda\\6+4\lambda\end{pmatrix}$ B1

08

$2x+y+4z = 13$

$2(3+2\lambda)+4+\lambda+4(6+4\lambda) = 13$ M1

$21\lambda+34 = 13$

$21\lambda = -21$ A1

$\lambda = -1$

$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}3+2(-1)\\4-1\\6+4(-1)\end{pmatrix}_{M1} = \begin{pmatrix}1\\3\\2\end{pmatrix}$ A1

$\therefore N$ is $(1,3,2)$ B1

11 (b) $\overrightarrow{NP} = \lambda\begin{pmatrix}2\\1\\4\end{pmatrix}$

$n = \begin{pmatrix}2\\1\\4\end{pmatrix}$ B1

$r \cdot n = a \cdot n$

$\begin{pmatrix}x\\y\\z\end{pmatrix}\cdot\begin{pmatrix}2\\1\\4\end{pmatrix} = \begin{pmatrix}1\\2\\-1\end{pmatrix}\cdot\begin{pmatrix}2\\1\\4\end{pmatrix}$ M1

04

$2x+y+4z = 2+2-4$ M1

$2x+y+4z = 0$ is the equation of plane A1

12 (a) $r_1 = r_2$

$\begin{pmatrix}2+\lambda\\1+\lambda\\2\lambda\end{pmatrix} = \begin{pmatrix}2+\mu\\2+2\mu\\t+\mu\end{pmatrix}$ M1

$2+\lambda = 2+\mu$

$-\;\; 1+\lambda = 2+2\mu$

$1 = -\mu_{M1} \Rightarrow \mu = -1$ A1

$\lambda = \mu \Rightarrow \lambda = -1$ A1

~~$2(-1) = t+(-1)$~~

07

$2(-1) = t-1$ M1

$t = -1$ A1

$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}2-1\\1-1\\2(-1)\end{pmatrix} = \begin{pmatrix}1\\0\\-2\end{pmatrix}$

B1

$\therefore t = -1$ and C is $(1,0,-2)$

(b) $d_1 = \begin{pmatrix}1\\1\\2\end{pmatrix}, \quad d_2 = \begin{pmatrix}1\\2\\1\end{pmatrix}$

$n = d_1 \wedge d_2 = \begin{vmatrix} i & j & k \\ 1 & 1 & 2 \\ 1 & 2 & 1 \end{vmatrix}$ M1

$= 3i - j - k$ A1

$n = \begin{pmatrix}3\\-1\\-1\end{pmatrix}$

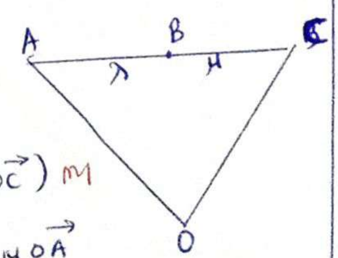
05

$\begin{pmatrix}x\\y\\z\end{pmatrix}\cdot\begin{pmatrix}3\\-1\\-1\end{pmatrix} = \begin{pmatrix}2\\1\\0\end{pmatrix}\cdot\begin{pmatrix}3\\-1\\-1\end{pmatrix}$ M1

$3x-y-z = 6-1+0$ M1

$3x-y-z = 5$ is the equation of the plane. A1

13 (a)



$\frac{\overrightarrow{AC}}{\overrightarrow{CB}} = -\frac{\lambda}{\mu}$ M

$\mu(\overrightarrow{OC}-\overrightarrow{OA}) = -\lambda(\overrightarrow{OB}-\overrightarrow{OC})$ M1

$\lambda\overrightarrow{OC} - \mu\overrightarrow{OC} = \lambda\overrightarrow{OB} - \mu\overrightarrow{OA}$

$(\lambda-\mu)\overrightarrow{OC} = \lambda b - \mu a$ M1

04

$\overrightarrow{OC} = \frac{\lambda b - \mu a}{\lambda - \mu}$ A1

$\vec{OP} = \dfrac{3\begin{pmatrix}-3\\-1\\-2\end{pmatrix} - 2\begin{pmatrix}5\\3\\6\end{pmatrix}}{3-2}$ M $= \begin{pmatrix}-9\\-3\\-6\end{pmatrix} - \begin{pmatrix}10\\6\\12\end{pmatrix}$ A1

$\vec{OP} = \begin{pmatrix}-19\\-9\\-18\end{pmatrix}$ A1

$\vec{OQ} = \dfrac{-1\begin{pmatrix}-3\\-1\\-2\end{pmatrix} + 5\begin{pmatrix}5\\3\\6\end{pmatrix}}{5-1}$ M1 $= \frac{1}{4}\begin{pmatrix}28\\16\\32\end{pmatrix} = \begin{pmatrix}7\\4\\8\end{pmatrix}$ A1

$R = \left(\frac{-19+7}{2}, \frac{-9+4}{2}, \frac{-18+8}{2}\right)$ B1

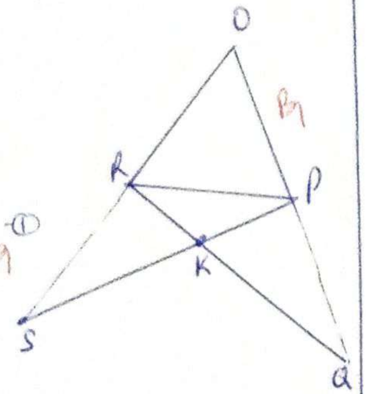
R is $(-6, -5/2, -5)$ (05)

(c) $d = \begin{pmatrix}2\\-3\\1\end{pmatrix}$ B1

$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}-6\\-5/2\\-5\end{pmatrix} + \lambda\begin{pmatrix}2\\-3\\1\end{pmatrix}$ M1 (03)

$\frac{x+6}{2} = \frac{y+5/2}{-3} = z+5$ is the equation of the line. A1

14



$\vec{OK} = \vec{OP} + \lambda\vec{PS}$

$\vec{PS} = \vec{OS} - \vec{OP}$

$= 2r - p$

$\vec{OK} = p + \lambda(2r - p)$ --- ① B1

$\vec{OK} = \vec{OR} + \mu\vec{RQ}$

$\vec{RQ} = \vec{OQ} - \vec{OR}$

$= \frac{3}{2}p - r$

$= \frac{3p - 2r}{2}$

$\vec{OK} = r + \frac{\mu}{2}(3p - 2r)$ --- ② B1

comparing ① and ②

$r: \ 2\lambda = 1 - \mu$

$p \ \ 1 - \lambda = \frac{3}{2}\mu$

$2 - 2\lambda = 3\mu$

$+ \ 2\lambda = 1 - \mu$

$2 = 1 + 2\mu$ M1

$2\mu = 1 \Rightarrow \mu = 1/2$ A1

$2\lambda = 1 - \mu \Rightarrow 2\lambda = 1 - 1/2$

$\lambda = 1/4$ M1

$\vec{OK} = p + \frac{1}{4}(2r - p) = \frac{4p + 2r - p}{4}$

$\vec{OK} = \frac{1}{4}(3p + 2r)$ B1

$\vec{PK} = -\vec{OP} + \vec{OK} = -p + \frac{1}{4}(3p + 2r)$

$\vec{PK} = \frac{1}{4}(2r - p)$ B1

$\vec{PS} = 2r - p \Rightarrow \vec{KS} = \vec{PS} - \vec{PK} = \left(1 - \frac{1}{4}\right)(2r - p)$

$= \frac{3}{4}(2r - p)$ (12)

$\frac{\vec{PK}}{\vec{KS}} = \dfrac{\frac{1}{4}(2r-p)}{\frac{3}{4}(2r-p)}$ M1 $= \frac{1}{3}$ A1

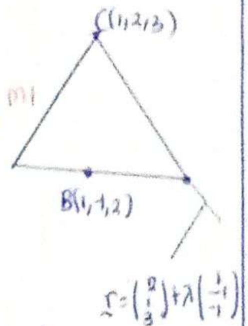
$\therefore$ K divides $\vec{PS}$ in the ratio $1:3$ B1

15 (a) $d_1 = \begin{pmatrix}1\\2\\3\end{pmatrix}$, $d_2 = \begin{pmatrix}1\\-3\\-1\end{pmatrix}$ B1 (05)

$n = d_1 \wedge d_2 = \begin{vmatrix} i & j & k \\ 1 & 2 & 3 \\ 1 & -3 & -1 \end{vmatrix}$ M1 $= 7i + 4j - 5k$ A1

$r \cdot n = a \cdot n \Rightarrow \begin{pmatrix}x\\y\\z\end{pmatrix}\cdot\begin{pmatrix}7\\4\\-5\end{pmatrix} = \begin{pmatrix}2\\-1\\2\end{pmatrix}\cdot\begin{pmatrix}7\\4\\-5\end{pmatrix}$ M1

$7x + 4y - 5z = 0$ is the equation of plane A1



(b) $n = \begin{pmatrix}2\\1\\3\end{pmatrix} - \begin{pmatrix}1\\-1\\2\end{pmatrix} = \begin{pmatrix}1\\2\\1\end{pmatrix}$ M

$r \cdot n = a \cdot n \Rightarrow \begin{pmatrix}x\\y\\z\end{pmatrix}\cdot\begin{pmatrix}1\\2\\1\end{pmatrix} = \begin{pmatrix}1\\-1\\2\end{pmatrix}\cdot\begin{pmatrix}1\\2\\1\end{pmatrix}$ M1

$x + 2y + z = 1$ is equation of the base A1

$r = \begin{pmatrix}2+t\\1-t\\3-t\end{pmatrix}$

$x + 2y + z = 1$ M1

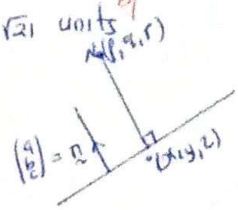
$2+t + 2(1-t) + 3 - t = 1 \Rightarrow 2t = 6 \Rightarrow t = 3$ A1

$A = (2+3, 1-3, 3-3) \Rightarrow A$ is $(5, -2, 0)$ B1

$\vec{AB} = \begin{pmatrix}5\\-2\\0\end{pmatrix} - \begin{pmatrix}1\\-1\\2\end{pmatrix} = \begin{pmatrix}4\\-1\\-2\end{pmatrix}$ B1 (07)

$|\vec{AB}| = \sqrt{(4)^2 + (-1)^2 + (-2)^2} = \sqrt{21}$ units B1

16 (a)



$\vec{PN} = \begin{pmatrix}x-p\\y-q\\z-r\end{pmatrix} = \lambda\begin{pmatrix}a\\b\\c\end{pmatrix}$

$\begin{pmatrix}x\\y\\z\end{pmatrix} = \begin{pmatrix}p+\lambda a\\q+\lambda b\\r+\lambda c\end{pmatrix}$

$ax + by + cz = d$

$a(p + \lambda a) + b(q + \lambda b) + c(r + \lambda c) = d$ M1

$ap + bq + cr + \lambda(a^2 + b^2 + c^2) = d$ (05)

$|-\lambda(a^2+b^2+c^2)| = |ap + bq + cr - d|$

$\lambda = \dfrac{|ap + bq + cr - d|}{a^2 + b^2 + c^2}$ B1

$|\vec{PN}| = \lambda\left|\begin{pmatrix}a\\b\\c\end{pmatrix}\right| = \lambda\sqrt{a^2+b^2+c^2} = \dfrac{|ap + bq + cr - d|}{a^2+b^2+c^2}\sqrt{a^2+b^2+c^2}$ M1

Shortest length $= \dfrac{|ap + bq + cr - d|}{\sqrt{a^2+b^2+c^2}}$ A1 (03)

(b) $l = \dfrac{14}{\sqrt{(2)^2 + (-1)^2 + (3)^2}}$ M1 $= \frac{14}{7}$ M1 $= 2$ units A1 (04)

(c) $d = \dfrac{|28 - -21|}{\sqrt{(4)^2 + (-12)^2 + (6)^2}}$ M1 M1 $= \frac{49}{14}$ M1 $= 3.5$ units A1