| Question Number | Scheme | Marks |
|---|---|---|
| Q7 (a) | If the lines meet, $-1+3\lambda=-4+3\mu$ and $2+4\lambda=2\mu$ | M1 |
| | Solve to give $\lambda=0$ $(\mu=1$ but this need not be seen$)$. | M1 A1 |
| | Also $1-\lambda=\alpha$ and so $\alpha=1$. | B1 (4) |
| (b) | $\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -1 & 3 & 4 \\ 0 & 3 & 2 \end{vmatrix}$ = -6**i**+2**j**-3**k** is perpendicular to both lines and hence to the plane | M1 A1 |
| | The plane has equation **r.n**=**a.n ,** which is $-6x + 2y - 3z = -14$, | M1 |
| | i.e. $-6x + 2y - 3z + 14 = 0$. | A1 o.a.e. (4) |
| OR (b) | **Alternative scheme**<br>Use (1, -1,2) and ($\alpha$ ,-4,0) in equation $ax+by+cz+d=0$<br>And third point so three equations, and attempt to solve<br>Obtain $6x-2y+3z=$<br>$(6x-2y+3z)-14=0$ | M1<br>M1<br>A1<br>A1 o.a.e. (4) |
| (c) | $\mathbf{(a_1 - a_2) = i - 3j - 2k}$ | M1 |
| | Use formula $\dfrac{(\mathbf{a}_1-\mathbf{a}_2)\bullet\mathbf{n}}{\lvert\mathbf{n}\rvert} = \dfrac{(\mathbf{i}-3\mathbf{j}-2\mathbf{k})\bullet(-6\mathbf{i}+2\mathbf{j}-3\mathbf{k})}{\sqrt{(36+4+9)}} = \left(\dfrac{-6}{7}\right)$ | M1 |
| | Distance is $\dfrac{6}{7}$ | A1 (3) **[11]** |

| Question Number | Scheme | Marks |
|---|---|---|
| **7(a)** | $\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -4 & 1 & 0 \\ 6 & -2 & 1 \end{vmatrix} = \begin{pmatrix} 1 \\ 4 \\ 2 \end{pmatrix}$ | M1 A2(1,0) |
| | $\begin{pmatrix} 1 \\ 4 \\ 2 \end{pmatrix} \bullet \begin{pmatrix} 3 \\ 0 \\ 1 \end{pmatrix} = 5$ | |
| | $\mathbf{r} \bullet \begin{pmatrix} 1 \\ 4 \\ 2 \end{pmatrix} = 5$ | M1A1 (5) |
| **(b)** | Equation of $l$ is $\mathbf{r} = \begin{pmatrix} 6 \\ 13 \\ 5 \end{pmatrix} + t\begin{pmatrix} 1 \\ 4 \\ 2 \end{pmatrix}$ | M1 |
| | At intersection $\begin{pmatrix} 6+t \\ 13+4t \\ 5+2t \end{pmatrix} \bullet \begin{pmatrix} 1 \\ 4 \\ 2 \end{pmatrix} = 5$ | M1 |
| | $\Rightarrow 6+t+4(13+4t)+2(5+2t)=5 \Rightarrow t=-3$ | M1 |
| | N is $(3,1,-1)$ * | A1 (4) |
| **(c)** | $\overrightarrow{PN} \bullet \overrightarrow{PR} = (-3\mathbf{i}-12\mathbf{j}-6\mathbf{k}) \bullet (-5\mathbf{i}-13\mathbf{j}-3\mathbf{k}) = 189$ | M1 A1ft |
| | $\sqrt{9+144+36}\sqrt{25+169+9}\cos NPR = 189$ | A1 |
| | $NX = NP\sin NPR = \sqrt{189}\sin NPR = 3.61$ | M1A1 (5) **14** |
| | | |

| Question Number | Scheme | Marks |
|---|---|---|
| **6.** **(a)** | $\mathbf{n} = (2\mathbf{j} - \mathbf{k}) \times (3\mathbf{i} + 2\mathbf{j} + 2\mathbf{k}) = 6\mathbf{i} - 3\mathbf{j} - 6\mathbf{k}$ o.a.e. (e.g. $2\mathbf{i} - \mathbf{j} - 2\mathbf{k}$) | M1 A1 (2) |
| **(b)** | Line $l$ has direction $2\mathbf{i} - 2\mathbf{j} - \mathbf{k}$<br>Angle between line $l$ and normal is given by $(\cos\beta \text{ or } \sin\alpha) = \frac{4+2+2}{\sqrt{9}\sqrt{9}} = \frac{8}{9}$<br>$\alpha = 90 - \beta = 63$ degrees to nearest degree. | B1<br>M1 A1ft<br>A1 awrt (4) |
| **(c) Alt 1** | Plane $P$ has equation $\mathbf{r}.(2\mathbf{i} - \mathbf{j} - 2\mathbf{k}) = 1$<br>Perpendicular distance is $\frac{1-(-7)}{\sqrt{9}} = \frac{8}{3}$ | M1 A1<br>M1 A1<br>(4)<br>**10** |
| **(c) Alt 2** | Parallel plane through A has equation $\mathbf{r}.\frac{2\mathbf{i} - \mathbf{j} - 2\mathbf{k}}{3} = \frac{-7}{3}$<br>Plane P has equation $\mathbf{r}.\frac{2\mathbf{i} - \mathbf{j} - 2\mathbf{k}}{3} = \frac{1}{3}$<br>So O lies between the two and perpendicular distance is $\frac{1}{3} + \frac{7}{3} = \frac{8}{3}$ | M1 A1<br>M1<br>A1<br>(4) |
| **(c) Alt 3** | Distance A to (3,1,2) = $\sqrt{2^2 + 2^2 + 1^2} = 3$<br>Perpendicular distance is ‘3’ sin $\alpha = 3 \times \frac{8}{9} = \frac{8}{3}$ | M1A1<br>M1A1<br>(4) |
| **(c) Alt 4** | Finding Cartesian equation of plane P: $2x - y - 2z - 1 = 0$<br>$d = \frac{\lvert n_1\alpha + n_2\beta + n_3\gamma + d\rvert}{\sqrt{n_1^2 + n_2^2 + n_3^2}} = \frac{\lvert 2(1) - 1(3) - 2(3) - 1\rvert}{\sqrt{2^2 + 1^2 + 2^2}} = \frac{8}{3}$ | M1 A1<br>M1A1<br>(4) |
| | **Notes:** | |
| **(a) M1** | Cross product of the correct vectors | |
| **A1** | CAO o.e. | |
| **(b) B1** | CAO | |
| **M1** | Angle between ‘$2\mathbf{i} - \mathbf{j} - 2\mathbf{k}$’ and $2\mathbf{i} - 2\mathbf{j} - \mathbf{k}$, formula of correct form | |
| **1A1ft** | 8/9ft | |
| **2A1** | CAO awrt | |
| **(c) 1M1** | Eqn of plane using $2\mathbf{i} - \mathbf{j} - 2\mathbf{k}$ **or** dist of A from O **or** finding length of AP | |
| **1A1** | Correct equation (must have = ) **or** A to (3,1,2) = 3 | |
| **2M1** | Using correct method to find perpendicular distance | |
| **2A1** | CAO | |

| Question Number | Scheme | Marks |
|---|---|---|
| **3. (a)** | $\overrightarrow{AC} = 3\mathbf{i} + 6\mathbf{j} + 2\mathbf{k}$ , $\overrightarrow{BC} = -3\mathbf{i} + 4\mathbf{j} + 3\mathbf{k}$<br>$\overrightarrow{AC} \times \overrightarrow{BC} = 10\mathbf{i} - 15\mathbf{j} + 30\mathbf{k}$ | B1, B1<br>M1 A1<br>(4) |
| **(b)** | Area of triangle $ABC$ = $\frac{1}{2}\left\|10\mathbf{i} - 15\mathbf{j} + 30\mathbf{k}\right\| = \frac{1}{2}\sqrt{1225} = 17.5$ | M1 A1<br>(2) |
| **(c)** | Equation of plane is $10x - 15y + 30z = -20$ or $2x - 3y + 6z = -4$<br>So **r.** (2**i** – 3**j** + 6**k)** = -4 or correct multiple | M1<br>A1 (2)<br>( 8 marks) |

**Notes**

a1B1: $\overrightarrow{AC} = 3\mathbf{i} + 6\mathbf{j} + 2\mathbf{k}$ cao, any form

a2B1: $\overrightarrow{BC} = -3\mathbf{i} + 4\mathbf{j} + 3\mathbf{k}$ cao, any form

a1M1: Attempt to find cross product, modulus of one term correct.

a1A1: cao, any form.

b1M1: modulus of their answer to (a) – condone missing ½ here. To finding area of triangle by correct method.

b1A1: cao.

c1M1: [Using their answer to (a) to] find **equation** of plane. Look for **a.n** or **b.n** or **c.n** for p.

c1A1: cao