

- 1 The line l has equation

$$\frac{x-3}{-1} = \frac{y+5}{2} = \frac{z-3}{-3}$$

A circle C has centre $(-2, -2, 2)$ and radius $7\sqrt{3}$.

Given that C intersects l at two points, A and B , find the coordinates of A and B . **(6 marks)**

- 2 Given that $\mathbf{a} = 3\mathbf{i} + \mathbf{j} - \mathbf{k}$ and $\mathbf{b} = -\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}$, find a vector which is perpendicular to both \mathbf{a} and \mathbf{b} . **(4 marks)**

- 3 The points A, B and C have coordinates $A(3, -4, 6), B(-1, 7, 2)$ and $C(8, 0, -5)$.
Find the area of triangle ABC . **(6 marks)**

- 4 The line with vector equation

$$\mathbf{r} = \begin{pmatrix} 1 \\ -3 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ -4 \\ -2 \end{pmatrix}$$

is perpendicular to the line with vector equation

$$\mathbf{r} = \begin{pmatrix} -16 \\ 5 \\ 3 \end{pmatrix} + \mu \begin{pmatrix} 2p \\ 1 \\ p \end{pmatrix}$$

- a** Find the value of p . **(2 marks)**
b Find the coordinates of the point of intersection of the lines. **(4 marks)**

- 5 The line l_1 has equation

$$\mathbf{r} = \begin{pmatrix} 6 \\ 2 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} 4 \\ 5 \\ -1 \end{pmatrix}$$

The plane Π has equation

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

The line l_2 is a reflection of the line l_1 in the plane Π .

Find an exact vector equation of the line l_2 . **(9 marks)**

- 6 A plane passes through three points P , Q and R , whose position vectors, referred to an origin O , are $P(2,1,5)$, $Q(-3,2,0)$ and $R(5,4,-1)$
- a Find, in the form $a\mathbf{i} + b\mathbf{j} + c\mathbf{k}$, a unit vector normal to this plane. **(5 marks)**
 - b Find a Cartesian equation for the plane. **(2 marks)**
 - c Find the acute angle between the plane in part **b** and the plane with vector equation $\mathbf{r} \cdot (3\mathbf{i} + 2\mathbf{j} - 8\mathbf{k}) = 7$ **(4 marks)**
- 7 Sumarine A wishes to move from point $P(6, -13, 14)$ to point $Q(16, -9, 12)$ where the unit of distance is kilometres.
- An enemy, submarine B, is located at a fixed point O . Submarine B has a radar that can detect motion within 15 km.
- a Can submarine A move from P to Q undetected by the radar of submarine B? **(7 marks)**
 - b State one limitation of the model. **(1 mark)**