A Level · Edexcel · Further Maths

53 mins 6 questions

6.2 Vector Planes

6.2.1 Equations of planes / 6.2.2 Combinations of Lines & Planes / 6.2.3 Combinations of Planes / 6.2.4 Shortest Distances - Planes

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Total Marks **/53**

1 The line l_1 has equation $\frac{x-2}{4} = \frac{y-4}{-2} = \frac{z+6}{1}$

The plane Π has equation $x - 2y + z = 6$

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

Find a vector equation of the line l_2

(7 marks)

2 (a) The plane Π_1 has vector equation

$$\mathbf{r}.(3\mathbf{i} - 4\mathbf{j} + 2\mathbf{k}) = 5$$

(a) Find the perpendicular distance from the point (6, 2, 12) to the plane Π_1

(3 marks)

(b) The plane Π_2 has vector equation

$$\mathbf{r} = \lambda(2\mathbf{i} + \mathbf{j} + 5\mathbf{k}) + \mu(\mathbf{i} - \mathbf{j} - 2\mathbf{k})$$

where λ and μ are scalar parameters.

(b) Show that the vector $-\mathbf{i} - 3\mathbf{j} + \mathbf{k}$ is perpendicular to Π_2

(2 marks)

(c) (c) Show that the acute angle between Π_1 and Π_2 is 52° to the nearest degree.

(3 marks)

3 (a) The plane Π_1 has equation

$$\mathbf{r} = 2\mathbf{i} + 4\mathbf{j} - \mathbf{k} + \lambda(\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}) + \mu(-\mathbf{i} + 2\mathbf{j} + \mathbf{k})$$

where λ and μ are scalar parameters.

(a) Find a Cartesian equation for Π_1

(4 marks)

(b) The line l has equation

$$\frac{x-1}{5} = \frac{y-3}{-3} = \frac{z+2}{4}$$

(b) Find the coordinates of the point of intersection l with Π_1

(3 marks)

(c) The plane Π_2 has equation

$$\mathbf{r}.(2\mathbf{i} - \mathbf{j} + 3\mathbf{k}) = 5$$

(c) Find, to the nearest degree, the acute angle between Π_1 and Π_2

(2 marks)

4 (a) $\boldsymbol{M} = \begin{pmatrix} k & 5 & 7 \\ 1 & 1 & 1 \\ 2 & 1 & -1 \end{pmatrix}$ where k is a constant

(a) Given that $k \neq 4$, find, in terms of k, the inverse of the matrix **M.**

(4 marks)

(b) (b) Find, in terms of p, the coordinates of the point where the following planes intersect.

$$2x + 5y + 7z = 1$$

$$x + y + z = p$$

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

(3 marks)

(c) (c) (i) Find the value of q for which the following planes intersect in a straight line.

$$4x + 5y + 7z = 1$$

$$x + y + z = q$$

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

(ii) For this value of q, determine a vector equation for the line of intersection.

(7 marks)

5 (a) The line l_1 has equation

$$\frac{x-1}{2} = \frac{y+1}{-1} = \frac{z-4}{3}$$

The line l_2 has equation

$$\mathbf{r} = \mathbf{i} + 3\mathbf{k} + t(\mathbf{i} - \mathbf{j} + 2\mathbf{k})$$

where t is a scalar parameter.

(a) Show that l_1 and l_2 lie in the same plane.

(3 marks)

(b) (b) Write down a vector equation for the plane containing l_1 and l_2

(1 mark)

6 (a) $\mathbf{M} = \begin{pmatrix} 2 & -1 & 1 \\ 3 & k & 4 \\ 3 & 2 & -1 \end{pmatrix}$ where k is a constant

(a) Find the values of k for which the matrix $\mathbf{M}$ has an inverse.

(2 marks)

(b) (b) Find, in terms of p, the coordinates of the point where the following planes intersect

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

$$3x - 6y + 4z = 1$$

$$3x + 2y - z = 0$$

(5 marks)

(c) (c) (i) Find the value of q for which the set of simultaneous equations

$$2x - y + z = 1$$

$$3x - 5y + 4z = q$$

$$3x + 2y - z = 0$$

can be solved.

(ii) For this value of q, interpret the solution of the set of simultaneous equations geometrically.

(4 marks)