PERFECT SOLUTION EDUCATION GROUP

JC MATHEMATICS (H2)

STUDY TIPS

FORMING VECTOR EQUATION OF A PLANE: NORMAL VECTOR HOLDS THE KEY

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JC_H2Maths_030

- **Scalar Product Form**

$$\overrightarrow{AR} \perp \mathbf{n} \Rightarrow \overrightarrow{AR} \cdot \mathbf{n} = 0 \Rightarrow (r - \mathbf{a}) \cdot \mathbf{n} = 0 \Rightarrow r \cdot \mathbf{n} - \mathbf{a} \cdot \mathbf{n} = 0$$

$$\boxed{\underset{\sim}{r} \cdot \underset{\sim}{n} = \underset{\sim}{a} \cdot \underset{\sim}{n} = p}$$

$$\Rightarrow \underset{\sim}{r} \cdot \begin{pmatrix} 4 \\ -5 \\ -7 \end{pmatrix} = \begin{pmatrix} 3 \\ 2 \\ 4 \end{pmatrix} \cdot \begin{pmatrix} 4 \\ -5 \\ -7 \end{pmatrix} = 12 - 10 - 28 = \underbrace{-26}_{p}$$

- **Cartesian Form**

$$r \cdot \mathbf{n} = p \Rightarrow \begin{pmatrix} x \\ y \\ z \end{pmatrix} \cdot \begin{pmatrix} \mathbf{n}_1 \\ \mathbf{n}_2 \\ \mathbf{n}_3 \end{pmatrix} = p \Rightarrow \boxed{n_1 x + n_2 y + n_3 z = p}$$

$$\Rightarrow 4x - 5y - 7z = -26$$ *

Quick Practice

Find a Cartesian equation of the plane given by

$$r = \underbrace{(2\mathbf{i} - \mathbf{j} + 3\mathbf{k})}_{\underset{\sim}{a}} + \lambda \underbrace{(\mathbf{i} - 4\mathbf{j} + 2\mathbf{k})}_{\underset{\sim}{b}} + \mu \underbrace{(-3\mathbf{i} + 2\mathbf{j} - \mathbf{k})}_{\underset{\sim}{c}}, \text{ where } \lambda, \mu \in \Re.$$

$$\underset{\sim}{n} = \begin{pmatrix} 1 \\ -4 \\ 2 \end{pmatrix} \times \begin{pmatrix} -3 \\ 2 \\ -1 \end{pmatrix} = \begin{pmatrix} 4 - 4 \\ -(-1+6) \\ 2 - 12 \end{pmatrix} = \begin{pmatrix} 0 \\ -5 \\ -10 \end{pmatrix} = -5 \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$$

$$\underset{\sim}{r} \cdot \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix} = \begin{pmatrix} 2 \\ -1 \\ 3 \end{pmatrix} \cdot \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix} = 0 - 1 + 6 = 5$$

$$\Rightarrow y + 2z = 5, \quad \underline{x \in \mathbb{R}}$$ *

If any x, y, z is missing, pls write something like this. [Tested in A-level before.]

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Explanation

When finding the equation of a plane from its vector form, following a structured sequence helps ensure accuracy and saves time.

Always simplify your normal vector first by checking if its directional components share a common factor, which allows you to reduce them to smaller, more manageable values for ease of calculation.

Once you have the simplest direction, proceed directly to the scalar product form to establish the relationship between a general point and your known vector.

From there, you can smoothly transform into the Cartesian form, where the individual components of your reduced normal vector directly become the numerical coefficients for your respective positional variables.

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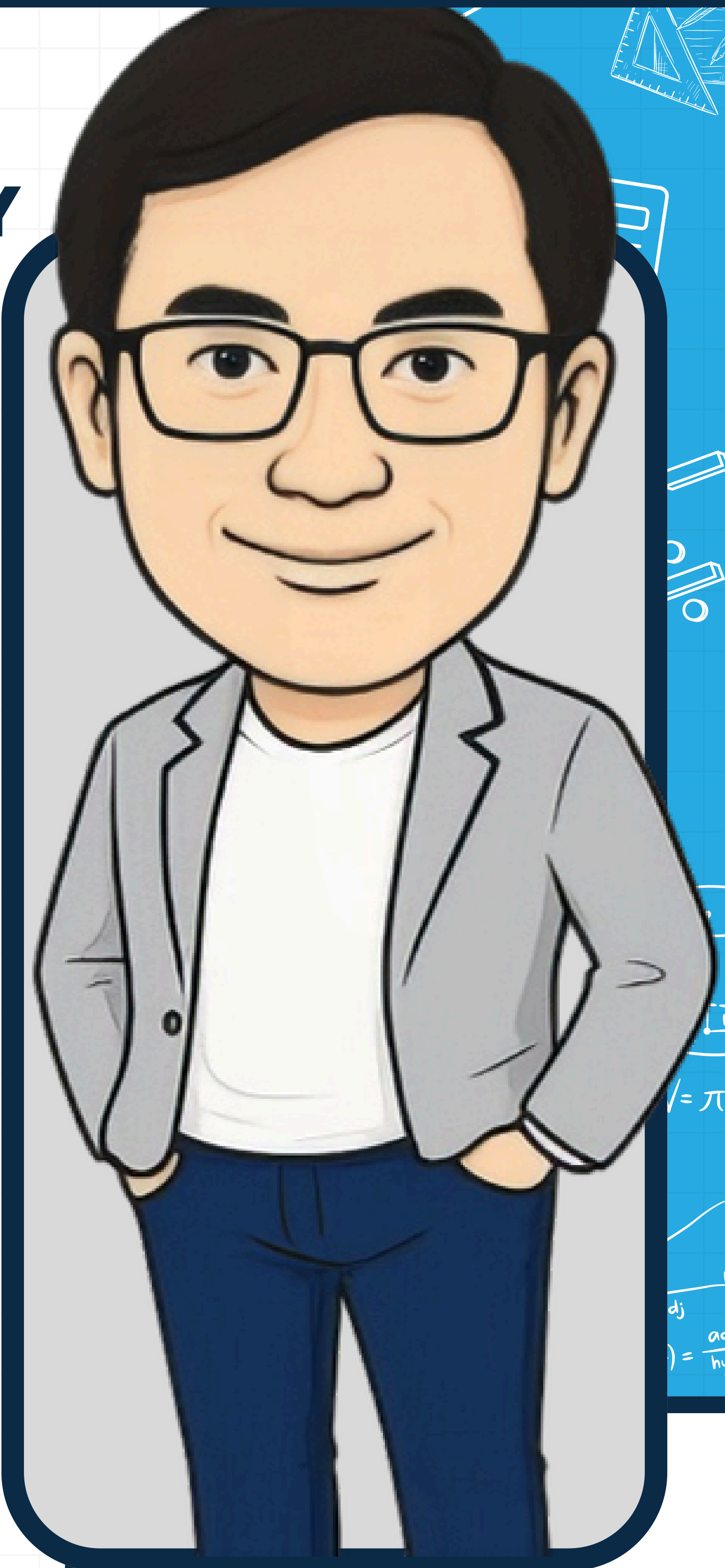

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