

- 11 The line l has equation $\mathbf{r} = \mathbf{i} - 2\mathbf{j} - 3\mathbf{k} + \lambda(-\mathbf{i} + \mathbf{j} + 2\mathbf{k})$. The points A and B have position vectors $-2\mathbf{i} + 2\mathbf{j} - \mathbf{k}$ and $3\mathbf{i} - \mathbf{j} + \mathbf{k}$ respectively.

(a) Find a unit vector in the direction of l . [2]

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The line m passes through the points A and B .

(b) Find a vector equation for m . [2]

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[illegible]

A fourth point C is such that $ABCD$ is a parallelogram.

- (a) Find the position vector of C and verify that the parallelogram is not a rhombus. [5]

(b) Find angle BAD , giving your answer in degrees.

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(c) Find the area of the parallelogram correct to 3 significant figures.

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- 9 Two lines l and m have equations $\mathbf{r} = 3\mathbf{i} + 2\mathbf{j} + 5\mathbf{k} + s(4\mathbf{i} - \mathbf{j} + 3\mathbf{k})$ and $\mathbf{r} = \mathbf{i} - \mathbf{j} - 2\mathbf{k} + t(-\mathbf{i} + 2\mathbf{j} + 2\mathbf{k})$ respectively.

(a) Show that l and m are perpendicular. [2]

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(b) Show that l and m intersect and state the position vector of the point of intersection. [5]

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- (c) Show that the length of the perpendicular from the origin to the line m is $\frac{1}{3}\sqrt{5}$. [4]

(a) Using a scalar product, find the cosine of angle BAC .

[4]

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- (a) Show that l does not intersect the line passing through A and B . [5]

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- 10 With respect to the origin O , the points A , B , C and D have position vectors given by

$$\overrightarrow{OA} = \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix}, \quad \overrightarrow{OB} = \begin{pmatrix} 1 \\ 2 \\ -3 \end{pmatrix}, \quad \overrightarrow{OC} = \begin{pmatrix} 1 \\ -2 \\ 5 \end{pmatrix} \quad \text{and} \quad \overrightarrow{OD} = \begin{pmatrix} 5 \\ -6 \\ 11 \end{pmatrix}.$$

- (a) Find the obtuse angle between the vectors $\overrightarrow{OA}$ and $\overrightarrow{OB}$. [3]

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The line l passes through the points A and B .

- (b) Find a vector equation for the line l . [2]

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[illegible]

- 9** With respect to the origin O , the point A has position vector given by $\overrightarrow{OA} = \mathbf{i} + 5\mathbf{j} + 6\mathbf{k}$. The line l has vector equation $\mathbf{r} = 4\mathbf{i} + \mathbf{k} + \lambda(-\mathbf{i} + 2\mathbf{j} + 3\mathbf{k})$.

- (a) Find in degrees the acute angle between the directions of OA and l . [3]

[illegible]

- (b) Find the position vector of the foot of the perpendicular from A to l . [4]

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- (c) Hence find the position vector of the reflection of A in l . [2]

- 10** The points A and B have position vectors $2\mathbf{i} + \mathbf{j} + \mathbf{k}$ and $\mathbf{i} - 2\mathbf{j} + 2\mathbf{k}$ respectively. The line l has vector equation $\mathbf{r} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k} + \mu(\mathbf{i} - 3\mathbf{j} - 2\mathbf{k})$.

- (a) Find a vector equation for the line through A and B . [3]

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- (b) Find the acute angle between the directions of AB and l , giving your answer in degrees. [3]

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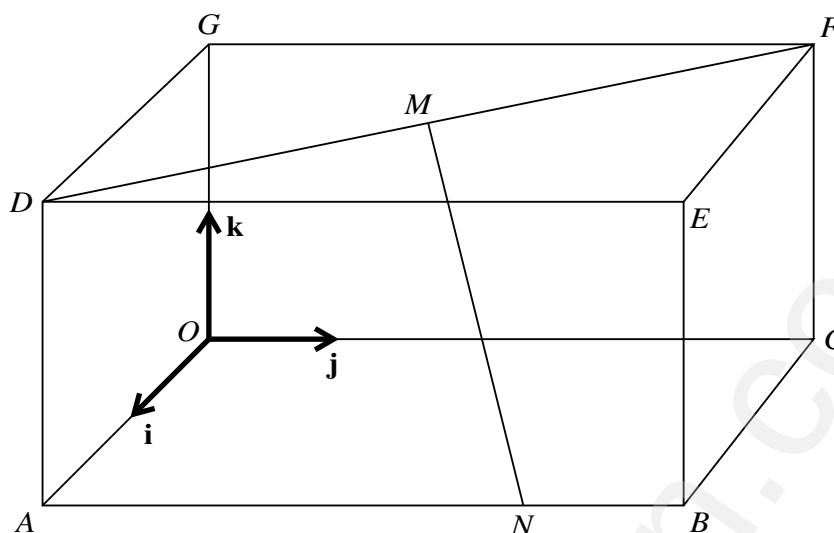
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In the diagram, $OABCDEFG$ is a cuboid in which $OA = 2$ units, $OC = 4$ units and $OG = 2$ units. Unit vectors $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$ are parallel to OA , OC and OG respectively. The point M is the midpoint of DF . The point N on AB is such that $AN = 3NB$.

- (a) Express the vectors $\overrightarrow{OM}$ and $\overrightarrow{MN}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$. [3]

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- (b) Find a vector equation for the line through M and N . [2]

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Relative to the origin O , the position vector of the point P is $4\mathbf{i} + 7\mathbf{j} - 2\mathbf{k}$.

$$l: \mathbf{r} = a\mathbf{i} + 3\mathbf{j} + b\mathbf{k} + \lambda(c\mathbf{i} - 2\mathbf{j} + 4\mathbf{k}),$$

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

Relative to the origin O , the position vector of the point P is $4\mathbf{i} + 7\mathbf{j} - 2\mathbf{k}$.

- (a) Given that l is perpendicular to m and that P lies on l , find the values of the constants a , b and c . [4]

[6]

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- 9 The quadrilateral $ABCD$ is a trapezium in which AB and DC are parallel. With respect to the origin O , the position vectors of A , B and C are given by $\vec{OA} = -\mathbf{i} + 2\mathbf{j} + 3\mathbf{k}$, $\vec{OB} = \mathbf{i} + 3\mathbf{j} + \mathbf{k}$ and $\vec{OC} = 2\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$.

- (a) Given that $\overrightarrow{DC} = 3\overrightarrow{AB}$, find the position vector of D . [3]

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- (b) State a vector equation for the line through A and B . [1]

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- 10 With respect to the origin O , the position vectors of the points A and B are given by $\vec{OA} = \begin{pmatrix} 1 \\ 2 \\ -1 \end{pmatrix}$ and $\vec{OB} = \begin{pmatrix} 0 \\ 3 \\ 1 \end{pmatrix}$.

(a) Find a vector equation for the line l through A and B . [3]

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(b) The point C lies on l and is such that $\vec{AC} = 3\vec{AB}$.

Find the position vector of C . [2]

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[illegible]

- (a) Show that $OA = OB$ and use a scalar product to calculate angle AOB in degrees. [4]

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- 11 Two lines have equations $\mathbf{r} = \mathbf{i} + 2\mathbf{j} + \mathbf{k} + \lambda(a\mathbf{i} + 2\mathbf{j} - \mathbf{k})$ and $\mathbf{r} = 2\mathbf{i} + \mathbf{j} - \mathbf{k} + \mu(2\mathbf{i} - \mathbf{j} + \mathbf{k})$, where a is a constant.

- (a) Given that the two lines intersect, find the value of a and the position vector of the point of intersection. [5]

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