



Higher Mathematics

Vectors - Questions

Marks are indicated in brackets after each question number

2013 Paper 1 Question 12, (2)

If $\mathbf{f} = 3\mathbf{i} + 2\mathbf{k}$ and $\mathbf{g} = 2\mathbf{i} + 4\mathbf{j} + 3\mathbf{k}$, find $|\mathbf{f} + \mathbf{g}|$.

2013 Paper 1 Question 14, (2)

Given that $|\mathbf{a}| = 3$, $|\mathbf{b}| = 2$ and $\mathbf{a} \cdot \mathbf{b} = 5$, what is the value of $\mathbf{a} \cdot (\mathbf{a} + \mathbf{b})$?

2013 Paper 1 Question 24, (4) (5)

- (a) (i) Show that the points A(-7, -8, 1), T(3, 2, 5) and B(18, 17, 11) are collinear.
- (ii) Find the ratio in which T divides AB.
- (b) The point C lies on the x -axis.
- If TB and TC are perpendicular, find the coordinates of C.

2014 Paper 1 Question 6, (2)

Given that $\mathbf{u} = \begin{pmatrix} -3 \\ 1 \\ 0 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix}$, find $2\mathbf{u} - 3\mathbf{v}$ in component form.

2014 Paper 1 Question 14, (2)

The vectors $\mathbf{u} = \begin{pmatrix} 1 \\ k \\ k \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} -6 \\ 2 \\ 5 \end{pmatrix}$ are perpendicular.

What is the value of k ?



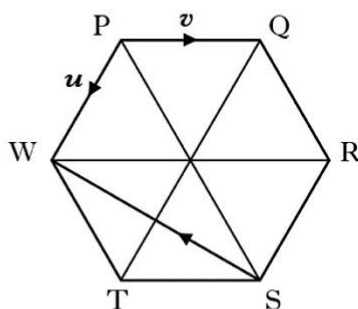
2014 Paper 1 Question 16, (2)

The unit vectors $\mathbf{a}$ and $\mathbf{b}$ are such that $\mathbf{a} \cdot \mathbf{b} = \frac{2}{3}$. Determine the value of $\mathbf{a} \cdot (\mathbf{a} + 2\mathbf{b})$.

2014 Paper 1 Question 19, (2)

The diagram shows a regular hexagon PQRSTW.

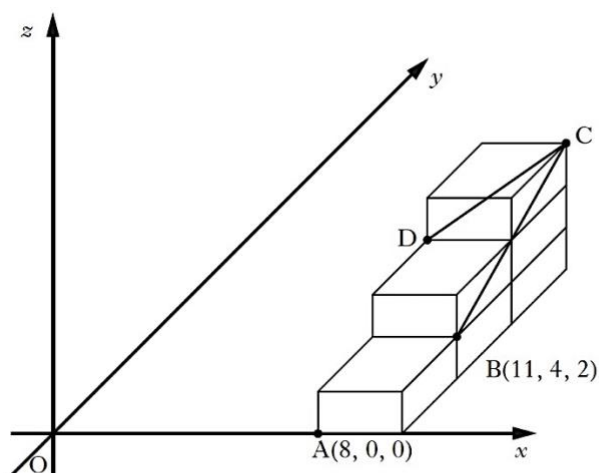
$\overrightarrow{PW}$ and $\overrightarrow{PQ}$ represent vectors $\mathbf{u}$ and $\mathbf{v}$ respectively.



What is $\overrightarrow{SW}$ in terms of $\mathbf{u}$ and $\mathbf{v}$?

2014 Paper 2 Question 4, (2) (2) (5)

Six identical cuboids are placed with their edges parallel to the coordinate axes as shown in the diagram.



A and B are the points $(8, 0, 0)$ and $(11, 4, 2)$ respectively.

(a) State the coordinates of C and D.

(b) Determine the components of $\overrightarrow{CB}$ and $\overrightarrow{CD}$.

(c) Find the size of the angle BCD.



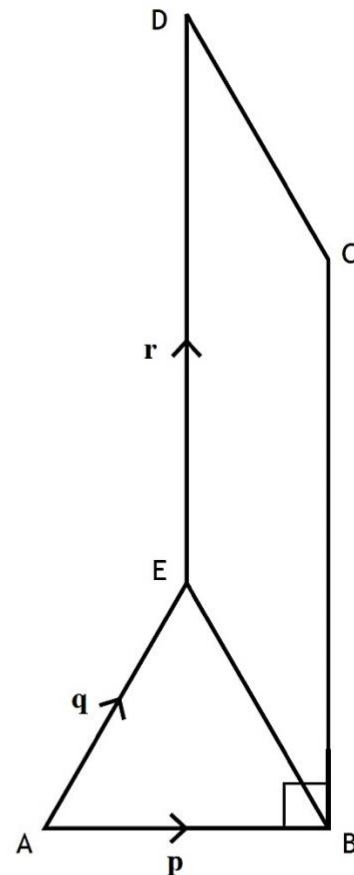
2015 Paper 1 Question 1, (2)

Vectors $\mathbf{u} = 8\mathbf{i} + 2\mathbf{j} - \mathbf{k}$ and $\mathbf{v} = -3\mathbf{i} + t\mathbf{j} - 6\mathbf{k}$ are perpendicular.
Determine the value of t .

2015 Paper 2 Question 6, (3) (1) (3)

Vectors $\mathbf{p}$, $\mathbf{q}$ and $\mathbf{r}$ are represented on the diagram as shown.

- BCDE is a parallelogram
- ABE is an equilateral triangle
- $|\mathbf{p}| = 3$
- Angle $ABC = 90^\circ$



- Evaluate $\mathbf{p} \cdot (\mathbf{q} + \mathbf{r})$.
- Express $\vec{EC}$ in terms of $\mathbf{p}$, $\mathbf{q}$ and $\mathbf{r}$.
- Given that $\vec{AE} \cdot \vec{EC} = 9\sqrt{3} - \frac{9}{2}$, find $|\mathbf{r}|$.



2016 Paper 1 Question 7, (2) (2)

Three vectors can be expressed as follows:

$$\vec{FG} = -2\mathbf{i} - 6\mathbf{j} + 3\mathbf{k}$$

$$\vec{GH} = 3\mathbf{i} + 9\mathbf{j} - 7\mathbf{k}$$

$$\vec{EH} = 2\mathbf{i} + 3\mathbf{j} + \mathbf{k}$$

(a) Find $\vec{FH}$.

(b) Hence, or otherwise, find $\vec{FE}$.

2016 Paper 1 Question 11, (2) (3)

(a) A and C are the points $(1, 3, -2)$ and $(4, -3, 4)$ respectively.

Point B divides AC in the ratio 1 : 2.

Find the coordinates of B.

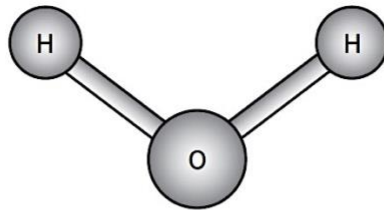
(b) $k\vec{AC}$ is a vector of magnitude 1, where $k > 0$.

Determine the value of k .



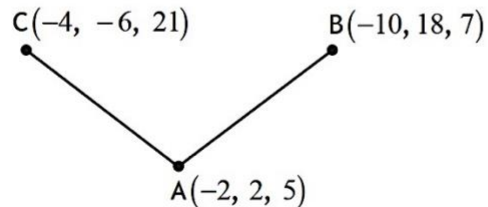
2016 Paper 2 Question 5, (2) (4)

The picture shows a model of a water molecule.



Relative to suitable coordinate axes, the oxygen atom is positioned at point $A(-2, 2, 5)$.

The two hydrogen atoms are positioned at points $B(-10, 18, 7)$ and $C(-4, -6, 21)$ as shown in the diagram below.

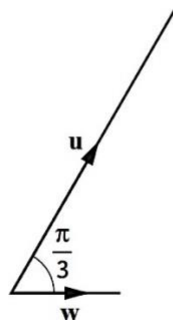


- (a) Express $\vec{AB}$ and $\vec{AC}$ in component form.
- (b) Hence, or otherwise, find the size of angle BAC.

2017 Paper 1 Question 5, (1) (3)

Vectors $\mathbf{u}$ and $\mathbf{v}$ are $\begin{pmatrix} 5 \\ 1 \\ -1 \end{pmatrix}$ and $\begin{pmatrix} 3 \\ -8 \\ 6 \end{pmatrix}$ respectively.

- (a) Evaluate $\mathbf{u} \cdot \mathbf{v}$.
- (b)



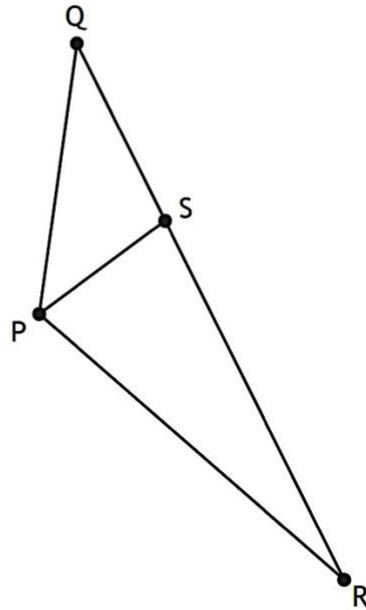
Vector $\mathbf{w}$ makes an angle of $\frac{\pi}{3}$ with $\mathbf{u}$ and $|\mathbf{w}| = \sqrt{3}$.

Calculate $\mathbf{u} \cdot \mathbf{w}$.



2017 Paper 2 Question 5, (2) (2) (5)

In the diagram, $\vec{PR} = 9\mathbf{i} + 5\mathbf{j} + 2\mathbf{k}$ and $\vec{RQ} = -12\mathbf{i} - 9\mathbf{j} + 3\mathbf{k}$.



- (a) Express $\vec{PQ}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$.

The point S divides QR in the ratio 1:2.

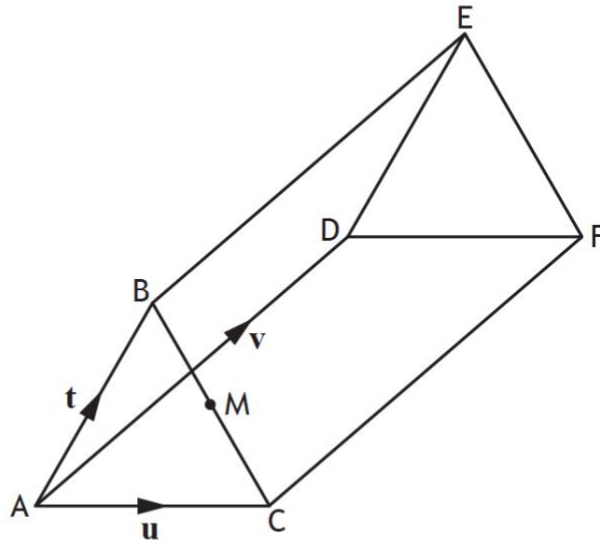
- (b) Show that $\vec{PS} = \mathbf{i} - \mathbf{j} + 4\mathbf{k}$.
- (c) Hence, find the size of angle QPS.



2018 Paper 1 Question 9, (1) (2)

The diagram shows a triangular prism ABC, DEF .

$\vec{AB} = \mathbf{t}$, $\vec{AC} = \mathbf{u}$ and $\vec{AD} = \mathbf{v}$.



(a) Express $\vec{BC}$ in terms of $\mathbf{u}$ and $\mathbf{t}$.

M is the midpoint of BC .

(b) Express $\vec{MD}$ in terms of $\mathbf{t}$, $\mathbf{u}$ and $\mathbf{v}$.

2018 Paper 1 Question 12, (1) (3)

Vectors $\mathbf{a}$ and $\mathbf{b}$ are such that $\mathbf{a} = 4\mathbf{i} - 2\mathbf{j} + 2\mathbf{k}$ and $\mathbf{b} = -2\mathbf{i} + \mathbf{j} + p\mathbf{k}$.

(a) Express $2\mathbf{a} + \mathbf{b}$ in component form.

(b) Hence find the values of p for which $|2\mathbf{a} + \mathbf{b}| = 7$.



2018 Paper 2 Question 2, (1) (4)

Vectors $\mathbf{u}$ and $\mathbf{v}$ are defined by $\mathbf{u} = \begin{pmatrix} -1 \\ 4 \\ -3 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} -7 \\ 8 \\ 5 \end{pmatrix}$.

- (a) Find $\mathbf{u} \cdot \mathbf{v}$.
- (b) Calculate the acute angle between $\mathbf{u}$ and $\mathbf{v}$.

2019 Paper 1 Question 5, (3) (1)

- (a) Show that the points $A(1,5,-3)$, $B(4,-1,0)$ and $C(8,-9,4)$ are collinear.
- (b) State the ratio in which B divides AC .

2019 Paper 1 Question 9, (1) (3) (2)

Vectors $\mathbf{u}$ and $\mathbf{v}$ have components $\begin{pmatrix} p \\ -2 \\ 4 \end{pmatrix}$ and $\begin{pmatrix} 2p+16 \\ -3 \\ 6 \end{pmatrix}$, $p \in \mathbb{R}$.

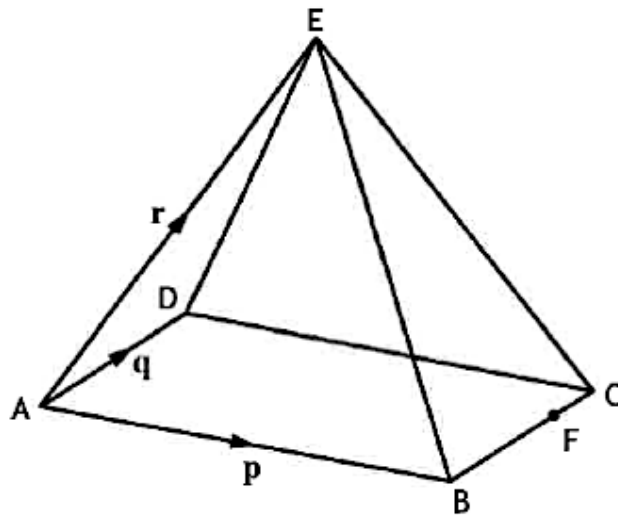
- (a)
 - (i) Find an expression for $\mathbf{u} \cdot \mathbf{v}$.
 - (ii) Determine the values of p for which $\mathbf{u}$ and $\mathbf{v}$ are perpendicular.
- (b) Determine the value of p for which $\mathbf{u}$ and $\mathbf{v}$ are parallel.



2019 Paper 2 Question 3, (1) (2)

E,ABCD is a rectangular based pyramid.

$\vec{AB} = \mathbf{p}$, $\vec{AD} = \mathbf{q}$ and $\vec{AE} = \mathbf{r}$.



(a) Express $\vec{BE}$ in terms of $\mathbf{p}$ and $\mathbf{r}$.

Point F divides BC in the ratio 3:1.

(b) Express vector $\vec{EF}$ in terms of $\mathbf{p}$, $\mathbf{q}$ and $\mathbf{r}$.

2019 Paper 2 Question 14, (4)

The vectors $\mathbf{u}$ and $\mathbf{v}$ are such that

- $|\mathbf{u}| = 4$
- $|\mathbf{v}| = 5$
- $\mathbf{u} \cdot (\mathbf{u} + \mathbf{v}) = 21$

Determine the size of the angle between the vectors $\mathbf{u}$ and $\mathbf{v}$.



2024 Paper 1 Question 4, (2)

P and Q have coordinates $(-6, 1, 2)$ and $(-1, 11, -8)$ respectively.

Find the coordinates of the point R which divides PQ in the ratio 2:3.

2024 Paper 2 Question 3, (2) (1) (4)

The coordinates of points D, E and F are given by D $(2, -3, 4)$, E $(1, 1, -2)$ and F $(3, 2, 1)$.

(a) Express $\overrightarrow{ED}$ and $\overrightarrow{EF}$ in component form.

(b) (i) Calculate $\overrightarrow{ED} \cdot \overrightarrow{EF}$.

(ii) Hence, or otherwise, calculate the size of angle DEF.

2025 Paper 1 Question 10, (5)

The vectors $\mathbf{u}$ and $\mathbf{v}$ are such that:

- $\mathbf{u} = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$

- $\mathbf{v} = \begin{pmatrix} 1 \\ 3 \\ k \end{pmatrix}$

- the angle between $\mathbf{u}$ and $\mathbf{v}$ is 45° .

Find the value of k , where $k > 0$.

2025 Paper 2 Question 5, (3) (1)

(a) Show that the points A $(-3, 2, -1)$, B $(6, -1, 5)$ and C $(12, -3, 9)$ are collinear.

(b) State the ratio in which B divides AC.



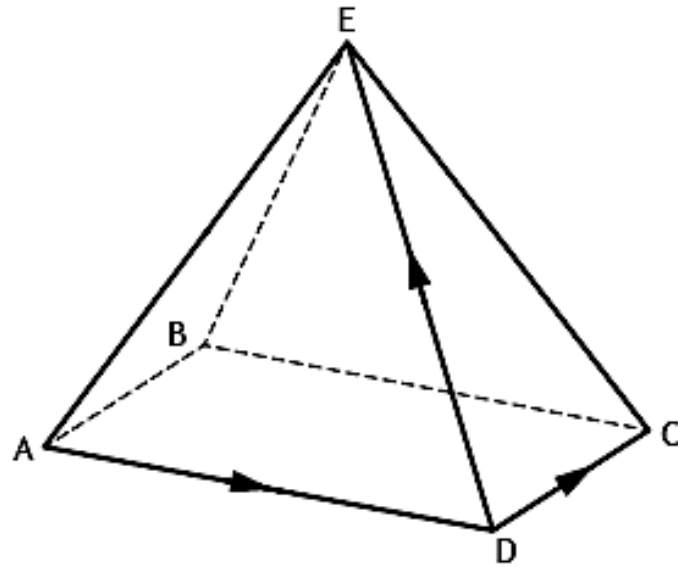
2025 Paper 2 Question 8, (2)

E,ABCD is a rectangular-based pyramid as shown.

$$\overrightarrow{AD} = 6\mathbf{i} + 4\mathbf{j} + 2\mathbf{k}$$

$$\overrightarrow{DC} = 2\mathbf{i} - 4\mathbf{j} + 2\mathbf{k}$$

$$\overrightarrow{DE} = -4\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$$



Express $\overrightarrow{BE}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$.



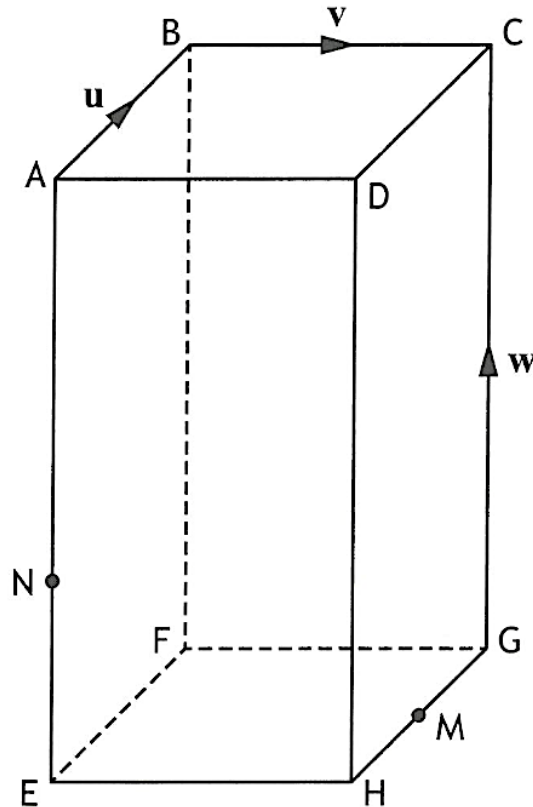
2026 Paper 1 Question 6, (2)

ABCD,EFGH is a cuboid.

$\overrightarrow{AB} = \mathbf{u}$, $\overrightarrow{BC} = \mathbf{v}$ and $\overrightarrow{GC} = \mathbf{w}$.

The point M is the mid-point of HG.

The point N divides EA with the ratio 1:2.



Express the vector $\overrightarrow{MN}$ in terms of $\mathbf{u}$, $\mathbf{v}$, and $\mathbf{w}$.

2026 Paper 1 Question 9, (3) (2)

(a) Show that the points D(-1,6,1), E(1,2,7) and F(2,0,10) are collinear.

Point G is such that F divides DG in the ratio 3:4.

(b) Find the coordinates of G.



2026 Paper 2 Question 2, (1) (4)

Vectors $\mathbf{u}$ and $\mathbf{v}$ are defined as $\mathbf{u} = \begin{pmatrix} 3 \\ 2 \\ 6 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} -5 \\ -2 \\ 4 \end{pmatrix}$.

- (a) Find $\mathbf{u} \cdot \mathbf{v}$.
- (b) Calculate the acute angle between $\mathbf{u}$ and $\mathbf{v}$.