

Subject – Math(Higher Level)
Topic - Vector
Year - Nov 2011 – Nov 2019

Question 1

[Maximum mark: 15]

(a) For non-zero vectors $\mathbf{a}$ and $\mathbf{b}$, show that

(i) if $|\mathbf{a} - \mathbf{b}| = |\mathbf{a} + \mathbf{b}|$, then $\mathbf{a}$ and $\mathbf{b}$ are perpendicular;

(ii) $|\mathbf{a} \times \mathbf{b}|^2 = |\mathbf{a}|^2 |\mathbf{b}|^2 - (\mathbf{a} \cdot \mathbf{b})^2$. [8 marks]

(b) The points A, B and C have position vectors $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$.

(i) Show that the area of triangle ABC is $\frac{1}{2} |\mathbf{a} \times \mathbf{b} + \mathbf{b} \times \mathbf{c} + \mathbf{c} \times \mathbf{a}|$.

(ii) Hence, show that the shortest distance from B to AC is

$$\frac{|\mathbf{a} \times \mathbf{b} + \mathbf{b} \times \mathbf{c} + \mathbf{c} \times \mathbf{a}|}{|\mathbf{c} - \mathbf{a}|}. \quad [7 \text{ marks}]$$

Question 2

[Maximum mark: 5]

Find the values of x for which the vectors $\begin{pmatrix} 1 \\ 2 \cos x \\ 0 \end{pmatrix}$ and $\begin{pmatrix} -1 \\ 2 \sin x \\ 1 \end{pmatrix}$ are perpendicular,
 $0 \leq x \leq \frac{\pi}{2}$.

Question 3

[Maximum mark: 6]

Two boats, A and B, move so that at time t hours, their position vectors, in kilometres, are $\mathbf{r}_A = (5t)\mathbf{i} + (3 - 6t)\mathbf{j}$ and $\mathbf{r}_B = (7 - 4t)\mathbf{i} + (7t - 6)\mathbf{j}$.

(a) Find the coordinates of the common point of the paths of the two boats. [4 marks]

(b) Show that the boats do not collide. [2 marks]

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