Question 1

[Maximum mark: 15]

(a)   For non-zero vectors a and b, show that

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

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

(b)   The points A, B and C have position vectors a, b and c.

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

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

$$\frac{|a \times b + b \times c + c \times a|}{|c - a|}.$$ *[7 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,

$0 \le x \le \dfrac{\pi}{2}$.

Question 3

[Maximum mark: 6]

Two boats, A and B, move so that at time t hours, their position vectors, in kilometres, are $r_A = (9t)i + (3 - 6t)j$ and $r_B = (7 - 4t)i + (7t - 6)j$.

(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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Lei Huang

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