

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

Question 1

$$\begin{aligned}
 (a) \quad (i) \quad & |a-b| = |a+b| \\
 \Rightarrow & (a-b) \cdot (a-b) = (a+b) \cdot (a+b) \\
 \Rightarrow & |a|^2 - 2a \cdot b + |b|^2 = |a|^2 + 2a \cdot b + |b|^2 \\
 \Rightarrow & 4a \cdot b = 0 \Rightarrow a \cdot b = 0 \\
 & \text{therefore } a \text{ and } b \text{ are perpendicular.}
 \end{aligned}$$

(M1)
A1
A1
R1

Notes: Allow use of 2-d components.

Notes: Do not consider sloppy vector notation, as we must see something to the effect that $|a|^2 = a \cdot a$ is clearly being used for the M1.

Notes: Allow a correct geometric argument, for example that the diagonals of a parallelogram have the same length only if it is a rectangle.

$$\begin{aligned}
 (ii) \quad & |a \times b|^2 = (|a||b|\sin\theta)^2 = |a|^2|b|^2\sin^2\theta \\
 & |a|^2|b|^2 - (a \cdot b)^2 = |a|^2|b|^2 - |a|^2|b|^2\cos^2\theta \\
 & = |a|^2|b|^2(1 - \cos^2\theta) \\
 & = |a|^2|b|^2\sin^2\theta \\
 \Rightarrow & |a \times b| = |a||b|\sin\theta = (a \cdot b)
 \end{aligned}$$

M1A1
M1
A1
AG
[5 marks]

$$\begin{aligned}
 (b) \quad (i) \quad & \text{area of triangle} = \frac{1}{2} |\vec{AB} \times \vec{AC}| \\
 & = \frac{1}{2} |(b-a) \times (c-a)| \\
 & = \frac{1}{2} |b \times c + b \times (-a) + (-a) \times c + (-a) \times (-a)| \\
 & b \times (-a) = a \times b, \quad c \times a = -a \times c, \quad -a \times (-a) = 0 \\
 \text{hence, area of triangle is } & \frac{1}{2} |a \times b + b \times c + c \times a|
 \end{aligned}$$

(M1)
A1
A1
M1
AG

$$\begin{aligned}
 (ii) \quad & D \text{ is the foot of the perpendicular from B to AC} \\
 \text{area of triangle } \triangle ABC &= \frac{1}{2} |\vec{AC}| |\vec{BD}| \\
 \text{therefore, } & \frac{1}{2} |\vec{AC}| |\vec{BD}| = \frac{1}{2} |\vec{AB} \times \vec{AC}| \\
 \text{hence, } |\vec{BD}| &= \frac{|\vec{AB} \times \vec{AC}|}{|\vec{AC}|} \\
 & = \frac{|a \times b + b \times c + c \times a|}{|c-a|}
 \end{aligned}$$

A1
M1
A1
AG

[7 marks]

Total [15 marks]

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