

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

Question 1

(a) (i) $|a-b| = |a+b|$
 $\Rightarrow (a-b) \cdot (a-b) = (a+b) \cdot (a+b)$ (M1)
 $\Rightarrow |a|^2 - 2a \cdot b + |b|^2 = |a|^2 + 2a \cdot b + |b|^2$ A1
 $\Rightarrow 4a \cdot b = 0 \Rightarrow a \cdot b = 0$ A1
 therefore a and b are perpendicular. 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.

(ii) $|a \times b|^2 = (|a||b|\sin\theta)^2 = |a|^2|b|^2\sin^2\theta$ M1A1
 $|a|^2|b|^2 = (a \cdot b)^2 = |a|^2|b|^2\cos^2\theta$ M1
 $= |a|^2|b|^2(1 - \sin^2\theta)$ A1
 $= |a|^2|b|^2\sin^2\theta$
 $\Rightarrow |a \times b|^2 = |a|^2|b|^2 - (a \cdot b)^2$ AG

[5 marks]

(b) (i) area of triangle $= \frac{1}{2} |\vec{AB} \times \vec{AC}|$ (M1)
 $= \frac{1}{2} |(b-a) \times (c-a)|$ A1
 $= \frac{1}{2} |b \times c + b \times -a + -a \times c + -a \times -a|$ A1
 $b \times -a = a \times b, \quad c \times a = -a \times c, \quad -a \times -a = 0$ M1
 Hence, area of triangle is $\frac{1}{2} |a \times b + b \times c + c \times a|$ AG

(ii) D is the foot of the perpendicular from B to AC
 area of triangle $\triangle ABC = \frac{1}{2} |\vec{AC}| |\vec{BD}|$ A1
 therefore:
 $\frac{1}{2} |\vec{AC}| |\vec{BD}| = \frac{1}{2} |\vec{AB} \times \vec{AC}|$ M1
 hence, $|\vec{BD}| = \frac{|\vec{AB} \times \vec{AC}|}{|\vec{AC}|}$ A1
 $= \frac{|a \times b + b \times c + c \times a|}{|c-a|}$ AG

[7 marks]

Total [15 marks]

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