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If $A = 2i - j$, $B = 3i + j - 11K$ and $C = 4i + 4j - 5K$

Find,

i) $-3A + 7B - 8C$

$-3(2i - j) + 7(3i + j - 11K) - 8(4i + 4j - 5K)$

$-6i + 3j + 21i + 7j - 77K - 32j - 32j + 40K$

$(-6i + 21i - 32i) + (+3j + 7j - 32j) + (-77K + 40K)$

$-17i - 22j - 37K$

ii) $K = 2A + 4B - C$ Find direction cosine

$K = 2[2i - j] + 4(3i + j - 11K] - 8(4j + 4i - 5K)$

$= 4i - 2j + 12i + 4j - 44K - 4i - 4j + 5K$

$= 12i + 6j - 49K$

$|K| = \sqrt{(12)^2 + (6)^2 + (49)^2}$

$|K| = \sqrt{144 + 36 + 2401}$

$= \sqrt{2581} = 50.80$

$x = \cos\alpha = 12/50.80$

$\alpha = \cos^{-1}\left(\frac{12}{50.80}\right)$

$\alpha = \cos^{-1}(0.2362)$

$\alpha = 1.33^\circ$

$y = \cos\alpha = \frac{6}{50.80}$

$\alpha = \cos^{-1}\left(\frac{6}{50.80}\right)$

$\alpha = \cos^{-1}(0.1181)$

$\alpha = 1.45^\circ$

$z = \cos\alpha = 49/50.80$

$\alpha = \cos^{-1}\left(\frac{49}{50.80}\right)$

$\alpha = \cos^{-1}(0.9646)$

$\alpha = 0.27^\circ$

iii) $A \times (B \times C)$

$$(B \times C) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 1 & -11 \\ 4 & 4 & -5 \end{vmatrix}$$

$$= \hat{i}\begin{vmatrix} 1 & -11 \\ 4 & -5 \end{vmatrix} - \hat{j}\begin{vmatrix} 3 & -11 \\ 4 & -5 \end{vmatrix} + \hat{k}\begin{vmatrix} 3 & 1 \\ 4 & 4 \end{vmatrix}$$

$$= \hat{i}(-5+44) - \hat{j}(-15+44) + \hat{k}(12-4)$$

$$= 39\hat{i} - 29\hat{j} + 8\hat{k}$$

$$\therefore A \times (B \times C) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -1 & 0 \\ 39 & -29 & 8 \end{vmatrix}$$

$$= \hat{i}\begin{vmatrix} -1 & 0 \\ -29 & 8 \end{vmatrix} - \hat{j}\begin{vmatrix} 2 & 0 \\ 39 & 8 \end{vmatrix} + \hat{k}\begin{vmatrix} 2 & -1 \\ 39 & -29 \end{vmatrix}$$

$$= -8\hat{i} - 16\hat{j} + 97\hat{k}$$

$$\therefore A \times (B \times C) = -8\hat{i} - 16\hat{j} + 97\hat{k}$$

iv) $(3A \times B) \cdot (A \times 2B)$

$3A = 3(2\hat{i} - \hat{j})$ $\qquad$ $2B = 2(3\hat{i} + \hat{j} - 11\hat{k})$

$= 6\hat{i} - 3\hat{j}$ $\qquad$ $= 6\hat{i} + 2\hat{j} - 22\hat{k}$

$$3A \times B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 6 & -3 & 0 \\ 3 & 1 & -11 \end{vmatrix}$$

$$\hat{i}\begin{vmatrix} -3 & 0 \\ 1 & -11 \end{vmatrix} - \hat{j}\begin{vmatrix} 6 & 0 \\ 3 & -11 \end{vmatrix} + \hat{k}\begin{vmatrix} 6 & -3 \\ 3 & 1 \end{vmatrix}$$

$66\hat{i} + 66\hat{j} + 15\hat{k}$,

$$A \times 2B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -1 & 0 \\ 6 & 2 & -22 \end{vmatrix}$$

$$\hat{i}\begin{vmatrix} -1 & 0 \\ 2 & -22 \end{vmatrix} - \hat{j}\begin{vmatrix} 2 & 0 \\ 6 & -22 \end{vmatrix} + \hat{k}\begin{vmatrix} 2 & -1 \\ 6 & 2 \end{vmatrix}$$

$= 22\hat{i} + 44\hat{j} + 10\hat{k}$

$(3A \times B) \cdot (A \times 2B)$

$(66\hat{i} + 66\hat{j} + 15\hat{k}) \cdot (22\hat{i} + 44\hat{j} + 10\hat{k})$

$= 1452\hat{i} + 2904\hat{k} + 150\hat{k}$

v) $A - 2B - C$

$2i - j - 6i - 2j + 22k - 4i + 4j - 5k$

$= -8\hat{i} + \hat{j} + 17\hat{k}$

2a) Vectors are said to be perpendicular if and only if their scalar product is equal to zero

b) Vectors are said to be co-planner if their scalar triple product is zero.