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① $M = Pi - 6j - 3k$, $N = 4i + 3j - k$, $O = i - 3j + 2k$.

a) M and N are perpendicular to each other.

$\therefore M.N = (Pi - 6j - 3k) \cdot (4i + 3j - k)$.

$= 4P - 18 + 3$.

$= 4P - 15$.

Since they are perpendicular,

$4P - 15 = 0$.

$P = 15/4$

b) M, N and O are co-planar.

$M \cdot (N \times O)$

$$N \times O = \begin{vmatrix} i & j & k \\ 4 & 3 & -1 \\ 1 & -3 & 2 \end{vmatrix}$$

$= i(6-3) - j(8+1) + k(-12-3)$

$= 3i - 9j - 15k$.

$\therefore M \cdot (N \times O) = (Pi - 6j - 3k) \cdot (3i - 9j - 15k)$

$= 3Pi + 54j + 45k$.

$\therefore 3P + 54 + 45 = 0$.

$3P + 99 = 0$

$P = -33$.

2) i) $v = (3i + 2j + 5k) + (i - j + 6k) + (5i + 2j - 3k)$.

$= 10i + 3j + 8k$.

$a_x = 10$, $a_y = 3$ and $a_z = 8$.

$|v| = \sqrt{10^2 + 3^2 + 8^2}$

$= \sqrt{100 + 9 + 64}$

$= \sqrt{173} = 13.15$.

direction of cosine are.

$\cos\alpha = \frac{a_x}{|v|} = \frac{10}{13.15} = 0.761$.

$\cos\beta = \frac{a_y}{|v|} = 3/13.15 = 0.228$.

$\cos\gamma = \frac{a_z}{|v|} = 8/13.15 = 0.608$.

ii) Unit vector : $\frac{v}{|v|} = \frac{10i + 3j + 8k}{13.15}$

3) $F = 3ui + u^2 j + (u+2)k.$

$v = 2ui - 3uj + (u-2)k$

$$F \times v = \begin{vmatrix} i & j & k \\ 3u & u^2 & (u+2) \\ 2u & -3u & (u-2)k \end{vmatrix}$$

$$F \times v = i[u^3 - 2u^2 + 3u^3 + 6u] - j[u^2 - 10u] + k[-2u^3 - 9u^2].$$

$$= i[u^3 + u^2 + 6u] - j[u^2 - 10u] + k[-2u^3 - 9u^2]$$

$$\int_0^1 (F \times v) = \int i[u^3 + u^2 + 6u] - \int j[u^2 - 10u] + \int k[-2u^3 - 9u^2].$$

$$= i\int u^3 + u^2 + 6u - j\int u^2 - 10u + k\int -2u^3 - 9u^2.$$

$$= i\left[\frac{u^4}{4} + \frac{u^3}{3} + \frac{6u}{2}\right] - j\left[\frac{u^3}{3} - \frac{10u}{2}\right] + k\left[\frac{2u^4}{4} - \frac{9u^3}{3}\right]. + c.$$

$$= i\left[\frac{u^4}{4} + \frac{u^3}{3} + 3u^2\right] - j\left[\frac{u^3}{3} - 5u^2\right] + k\left[\frac{-u^4}{2} - 3u^3\right] + c.$$

$$\int_0^1 (F \times v) = i\left[\frac{1^4}{4} + \frac{1^3}{4} + 3(1)^2\right] - j\left[\frac{(1)^3}{3} - 5(1)^2\right] + k\left[\frac{(-1)^4}{2} - 3(1)^3\right] + c - [0 + c]$$

taking the l.c.m.

$$\therefore \int_0^1 (F \times v) = i\left[\frac{43}{12}\right] - j\left[\frac{-14}{3}\right] + k\left[\frac{-7}{2}\right].$$

$$\therefore \int (F \times v) = \frac{43}{12} i - \frac{14}{3} j - \frac{7}{2} k. //$$