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1a. M & N are perpendicular

$M \cdot N = 0$

$(pi - 6j - 3k) \cdot (4i + 3j - k) = 0$

$4p - 18 + 3 = 0$

$4p - 15 = 0$

$p = 15/4$

b. M, N and O are coplanar

$M \cdot (N \times O) = 0$

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

$R_{11} = +i\,(6 - (-3 \times -1)) = +i(6 - (3)) = 3i$

$R_{12} = -j(8 - (-1 \times 1)) = -j(8 + 1) = -9j$

$R_{13} = +k(-12 - (3)) = +k(-12 - (3)) = -15k$

$\therefore M \cdot (M \times O) = 0$

$M \cdot (3i - 9j - 15k) = 0$

$(pi - 6j - 3k) \cdot (3i - 9j - 15k) = 0$

$3p + 54 + 45 = 0$

$3p + 99 = 0$

$p = -99/3$

$p = -33$

2. The sum of vectors

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

$3i+2i+5i+2j-j+2j+5k+6k-3k$

$10i+3j+8k$

(i) Direction cosines

$$\text{Magnitude} = \sqrt{10^2+3^2+8^2}$$
$$= \sqrt{173}$$

$$\cos\alpha = \frac{10}{\sqrt{173}} = 0.7601$$

$$\cos\beta = \frac{3}{\sqrt{173}} = 0.2281$$

$$\cos\gamma = \frac{8}{\sqrt{173}} = 0.6082$$

(ii) Unit vector of the sum

$$l_s = \frac{10i+3j+8k}{\sqrt{173}}$$

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

$R_{11} = +i\,((u^2(u-2)) - (-3u(u+2)))$
$= +i\,(u^3 - 2u^2 - (-3u^2 - 6u))$
$= +i\,(u^3 - 2u^2 + 3u^2 + 6u)$
$= +i\,(u^3 + u^2 + 6u)$

$R_{12} = -j\,(3u(u-2) - (2u(u+2)))$
$R_{12} = -j\,(3u^2 - 6u - (2u^2 + 4u))$
$= -j\,(3u^2 - 2u^2 - 6u - 4u)$
$= -j\,(u^2 - 10u)$

$R_{13} = +k\,(3u(-3u) - (2u(u^2)))$
$= +k\,(-9u^2 - (2u^3))$
$= k\,(-9u^2 - 2u^3)$

$\therefore \int_0^1 (u^3+u^2+6u)i + (-u^2+10u)j + (-9u^2-2u^3)k$

$= \left[\frac{u^4}{4} + \frac{u^3}{3} + \frac{6u^2}{2}\right]_0^1 i + \left[\frac{-u^3}{3} + \frac{10u^2}{2}\right]_0^1 j + \left[\frac{-9u^3}{3} - \frac{2u^4}{4}\right]_0^1 k$

$= \left[\frac{u^4}{4} + \frac{u^3}{3} + 3u^2\right]_0^1 i + \left[\frac{-u^3}{3} + 5u^2\right]_0^1 j + \left[-3u^3 - \frac{u^4}{2}\right]_0^1 k$

$$\left[\frac{1^4}{4} + \frac{1^3}{3} + 3(1)^2\right]i + \left[-\frac{1^3}{3} + 5(1)^2\right]j + \left[-3(1)^3 - \frac{1^4}{2}\right]k$$

$$= \left[43/12\right]i + \left[14/3\right]j + \left[-7/2\right]k$$

$$= 43/12\,i + 14/3\,j - 7/2\,k$$