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Mechatronics 100level Engineering
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(1) A particle moves along a curve, $x = t^2$, $y = -5t^2$, $z = t+7$, where t is time. Find its acceleration

$$r = xi + yj + zk$$

$$r = t^2 i - 5t^2 j + (t+7)k$$

$$\frac{dr}{dt} = 2ti - 10tj + 1k$$

$$\frac{d^2r}{dt^2} = 2i - 10j$$

(2) If $P = i - 9j - 4k$, $Q = 8i - 3j + 6k$, $R = i - 4j - 3k$

Find $(P \times Q) \cdot (R \times P)$

$$P \times Q = \begin{vmatrix} i & j & k \\ 1 & -9 & -4 \\ 8 & -3 & 6 \end{vmatrix} = i\begin{vmatrix} -9 & -4 \\ -3 & 6 \end{vmatrix} - j\begin{vmatrix} 1 & -4 \\ 8 & 6 \end{vmatrix} + k\begin{vmatrix} 1 & -9 \\ 8 & -3 \end{vmatrix}$$

$$= i(-54 - 12) - j(6 + 32) + k(-3 + 72)$$

$$= -66i - 38j + 69k$$

$$R \times P = \begin{vmatrix} i & j & k \\ 1 & -4 & -3 \\ 1 & -9 & -4 \end{vmatrix} = i\begin{vmatrix} -4 & -3 \\ -9 & -4 \end{vmatrix} - j\begin{vmatrix} 1 & -3 \\ 1 & -4 \end{vmatrix} + k\begin{vmatrix} 1 & -4 \\ 1 & -9 \end{vmatrix}$$

$$= i(16 - 27) - j(-4 + 3) + k(-9 + 4)$$

$$= -11i + j - 5k$$

$(P \times Q) \cdot (R \times P) = (-66x - 11)\, i \cdot i + (-38 \times 1)\, j \cdot j +$
$(69x - 5)\, k \cdot k$

$= 726 - 38 - 345$

$= 343$

3) $F = 5\cos 7t\, i - 2e^{3t}\, j - 4t^3\, k$, find the int.
egral of F with respect to t

$$\int F = 5\int \cos 7t\, i\, dt - 2\int e^{3t}\, j\, dt - 4\int t^3\, k\, dt$$

$u = 7t$

$\frac{du}{dt} = 7$

$dt = \frac{du}{7}$

$$\therefore \int F = 5\int \frac{\cos u}{7}\, du - 2\int e^{3t}\, j\, dt - 4\int t^3\, k\, dt$$

$$\int F = \frac{5}{7}\sin u\, i - \frac{2}{3}e^{3} - t^4$$

$$\therefore \int F = \frac{5}{7}\sin 7t\, i - \frac{2}{3}e^{3t}\, j - t^4\, k$$