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

Solution

$$\text{Acceleration} = \frac{d^2r}{dt^2}$$

To find the acceleration, we must first find dr/dt

$$r = xi + yj + zk$$

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

$$\frac{dr}{dt} = (2t)i + (10t + 1)j + (1)k$$

$$\frac{d^2r}{dt^2} = 2i + 10j + 0k$$

$$\therefore \frac{d^2r}{dt^2} = 2i + 10j + k$$

2 If $P = i - 9j - 4k$, $Q = 8i - 3j + 6k$, $R = i - 4j - 3k$, Find: $(\bar{P} \times \bar{Q}) \cdot (\bar{R} \times \bar{P})$

$$P \times Q = (i - 9j - 4k) \times (8i - 3j + 6k)$$

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

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

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

$$= -42i - 38j + 69k$$

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

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

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

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

$(\bar{P}\times\bar{Q})\cdot(\bar{R}\times\bar{P}) = (-42\bar{i} - 38\bar{j} + 69\bar{k})\cdot(-11\bar{i} + \bar{j} - 5\bar{k})$

$= 462 - 38 - 345$

$= 79$

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

Solution

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

$= \frac{5\sin(7t)}{7} + \frac{2e^{3t}}{3} - \frac{4t^4}{4} + C$

$\int F\,dt = \frac{5\sin(7t)}{7} - \frac{2e^{3t}}{3} - t^4 + C$