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1. The position vector (r)

$$r = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$$

$$r = (7t^2)\mathbf{i} + (6t^2 - 4t)\mathbf{j} + (t - 5)\mathbf{k}$$

$$\text{velocity} = \frac{dr}{dt} = (14t)\mathbf{i} + (12t - 4)\mathbf{j} + \mathbf{k}$$

$$\text{velocity} = (14t)\mathbf{i} + (12t - 4)\mathbf{j} + \mathbf{k}$$

2. $A \times (B \times C)$

$$(B \times C) = \begin{vmatrix} + & - & + \\ \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 2 & -3 & 1 \\ 0 & 4 & -3 \end{vmatrix}$$

$$R_{11} = \mathbf{i} (9 - 4) = 5\mathbf{i}$$

$$R_{12} = -\mathbf{j} (-6 - 0) = 6\mathbf{j}$$

$$R_{13} = \mathbf{k} (8 - 0) = 8\mathbf{k}$$

$$(B \times C) = 5\mathbf{i} + 6\mathbf{j} + 8\mathbf{k}$$

$$A \times (B \times C) = \begin{vmatrix} + & - & + \\ \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 1 & 2 & -4 \\ 5 & 6 & 8 \end{vmatrix}$$

$$R_{11} = \mathbf{i} (16 - (-24)) = 40\mathbf{i}$$

$$R_{12} = -\mathbf{j} (8 - (-20)) = -28\mathbf{j}$$

$$R_{13} = \mathbf{k} (6 - 10) = -4\mathbf{k}$$

$$A \times (B \times C) = 40\mathbf{i} - 28\mathbf{j} - 4\mathbf{k}$$

3. $R = 4\sin 3t\mathbf{i} + 4e^{3t}\mathbf{j} + 7t^3\mathbf{k}$

$$= \int 4\sin 3t\mathbf{i} + \int 4e^{3t}\mathbf{j} + \int 7t^3\mathbf{k}$$

$$= 4\mathbf{i} \int \sin 3t + 4\mathbf{j} \int e^{3t} + 7\mathbf{k} \int t^3$$

$$= 4\mathbf{i} \left[-\frac{1}{3} \cos 3t \right] + 4\mathbf{j} \left[\frac{1}{3} e^{3t} \right] + 7\mathbf{k} \left[\frac{t^4}{4} \right]$$

$$= \left(-\frac{4}{3} \cos 3t \right) \mathbf{i} + \left(\frac{4}{3} e^{3t} \right) \mathbf{j} + \left(\frac{7t^4}{4} \right) \mathbf{k}$$

$$4. (A+C) = (7i + 2j - k) + (i + j + k)$$

$$= 7i + i + 2j + j + k - k$$

$$= 8i + 3j$$

$$(B-A) = (2i + j + 4k) - (7i + 2j - k)$$

$$= (2i + j + 4k) - 7i - 2j + k$$

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

$$(A+C) \cdot (B-A) = (8i + 3j + k) \cdot (-5i - j + 5k)$$

$$= -40 - 3$$

$$= -43$$

$$5. \quad \bar{T} = \frac{dr/dt}{|dr/dt|_{t=?}}$$

$$r = xi + yj + zk$$

$$r = ti + t^2j + t^3k$$

$$\frac{dr}{dt} = i + 2tj + 3t^2k$$

$$t = 1 = i + 2j + 3k$$

$$\text{magnitude} = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{14}$$

$$\bar{T} = \frac{i + 2j + 3k}{\sqrt{14}}$$