Goal: Find the work done by electric forces in moving a charge $Q = 1\,\text{nC}$ from the coordinate origin to the point $(1\,\text{m}, 1\,\text{m}, 1\,\text{m})$ in the electrostatic field given by $\mathbf{E}(x, y, z) = (x\mathbf{a}_x + y^2\mathbf{a}_y - \mathbf{a}_z)$ V/m along the straight line.

Steps:

1. Choose a path that would facilitate the computation of the work, based on the fact that $\int_C \mathbf{E} \cdot d\mathbf{l}$ is path-independent.

   Solution: The parametric line describing the path from origin to point $(1\,\text{m}, 1\,\text{m}, 1\,\text{m})$ is given by:

$$\mathbf{l}(t) = t\,(\mathbf{a}_x + \mathbf{a}_y + \mathbf{a}_z)\ \ [\text{m}] \quad t \in [0, 1]$$

2. Compute scalar potential difference between point $(1\,\text{m}, 1\,\text{m}, 1\,\text{m})$ and the origin.

   Solution:

$$\begin{aligned} V &= -\int_0^1 \mathbf{E}(x, y, z) \cdot d\mathbf{l}(t) \\ &= -\int_0^1 (x\mathbf{a}_x + y^2\mathbf{a}_y - \mathbf{a}_z) \cdot (\mathbf{a}_x + \mathbf{a}_y + \mathbf{a}_z)\,dt \\ &= 0.1667\ [\text{V}] \end{aligned}$$

3. Use the potential to compute work done by electric forces, recalling the fundamental definition of electric potential difference as work per unit charge.

   Solution:

$$\begin{aligned} W &= qV \\ &= 166.67\,\text{pJ} \end{aligned}$$

   Therefore, the work done by the electric field is $-166.67\,\text{pJ}$.

Answer: W= - 166.67 pJ