Potential Energy of Charged Particle in Uniform Electric Field

- Electrostatic force: $\vec{F} = -qE\hat{j}$ (conservative)

- Displacement: $d\vec{s} = dx\hat{i} + dy\hat{j}$

- Work: $W_{if} = \displaystyle\int_i^f \vec{F} \cdot d\vec{s} = \int_{y_i}^{y_f} (-qE)dy = -qE(y_f - y_i)$

- Potential energy: $U = -\displaystyle\int_0^y (-qE)dy = qEy$

- Electric potential: $V(y) = Ey$