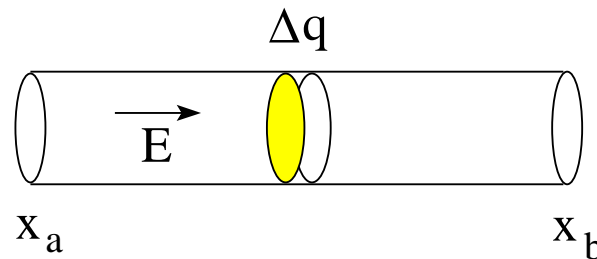Consider a resistor in the form of a uniform wire.

- Voltage between ends: $V \equiv V_a - V_b = E(x_b - x_a)$
- Displaced charge: $\Delta q = I \Delta t$



- Work done by electric field $\vec{E}$ on displaced charge $\Delta q$:

$$W_E = F(x_b - x_a) = E \Delta q (x_b - x_a) = V \Delta q = VI\Delta t$$

- Power dissipated in resistor: $P = \dfrac{W_E}{\Delta t} = VI = I^2 R = \dfrac{V^2}{R}$

- SI unit: 1V·1A = (1J/C)·(1C/s) = 1J/s = 1W    (Watt)