

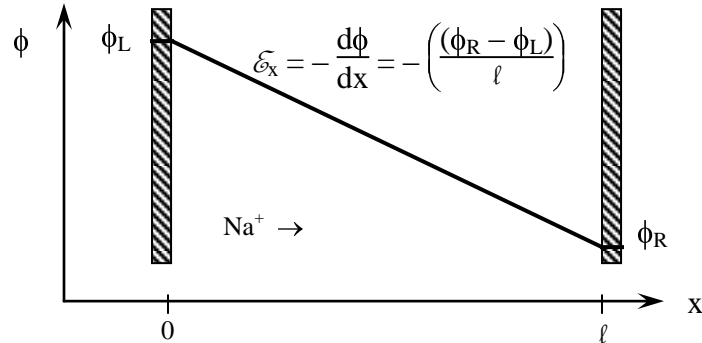
Electric Flux: Generalized Flux-Force Relationships

$$I \sim \text{amps} = \text{C s}^{-1}$$

$$I = -J_{\text{el}} A$$

$$J_{\text{el}} \sim \text{amps m}^{-2} = \text{C m}^{-2} \text{ s}^{-1}$$

$$I = \frac{1}{R} \Delta\phi$$



$$\kappa \equiv \frac{1}{R} \left(\frac{\ell}{A} \right) \quad \frac{1}{R} = \left(\frac{\kappa A}{\ell} \right)$$

$$I = \left(\frac{\kappa A}{\ell} \right) \Delta\phi$$

$$J_{\text{el}} = -I/A$$

external: circuit current ←

internal: cation current → (cations migrate to cathode)

$$J_{\text{el}} = -\kappa \left(\frac{\Delta\phi}{\ell} \right)$$

$$\mathcal{E}_x = -\frac{d\phi}{dx} = -\left(\frac{(\phi_R - \phi_L)}{\ell} \right) = -\left(\frac{\Delta\phi}{\ell} \right)$$

$$d\phi/dx = \Delta\phi/\ell$$

$$J_{\text{el}} = -\kappa \frac{d\phi}{dx}$$

⚡ Generalized Flux-Force relationships:

$$J_i = L_i X_i$$

J_i is the flux, which is the flow per unit time per unit area

X_i is the generalized force for the transfer (gradient in c, ϕ, T)

L_i is a linear coefficient

Compare generalized flux relationships with Ohm's Law:

$$J_i = L_i X_i \quad \longleftrightarrow \quad I = \frac{1}{R} \Delta\phi$$

$$\text{Diffusion } J_m = -D \frac{dc}{dx} \quad \text{Heat } J_q = -\kappa_T \frac{dT}{dx}$$