$$\frac{V}{R} = I$$

$$VI = P_{[watt]}$$

$$P \cdot t = U_{[watt \cdot hour]}$$

$$\frac{220\ _{[volt]}}{R_{[ohm]}} = 10_{[amper]}$$

$$220_{[volt]} \cdot I_{[amper]} = 2200_{[watt]}$$

$$2200_{[watt]} \cdot 1_{[hour]} = 2.2_{[kilowatt \cdot hour]}$$

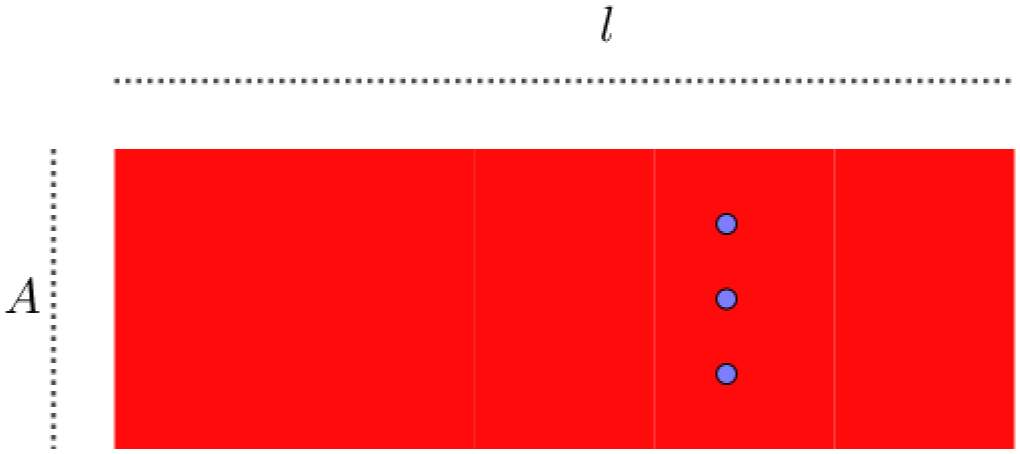
$$series \Rightarrow R_{tot} = \Sigma R_i = \int dR$$

$$parallel \Rightarrow \frac{1}{R_{tot}} = \Sigma \frac{1}{R_i} = \int \frac{1}{dR}$$

$$R_{tot} = R + R + R = 3R$$

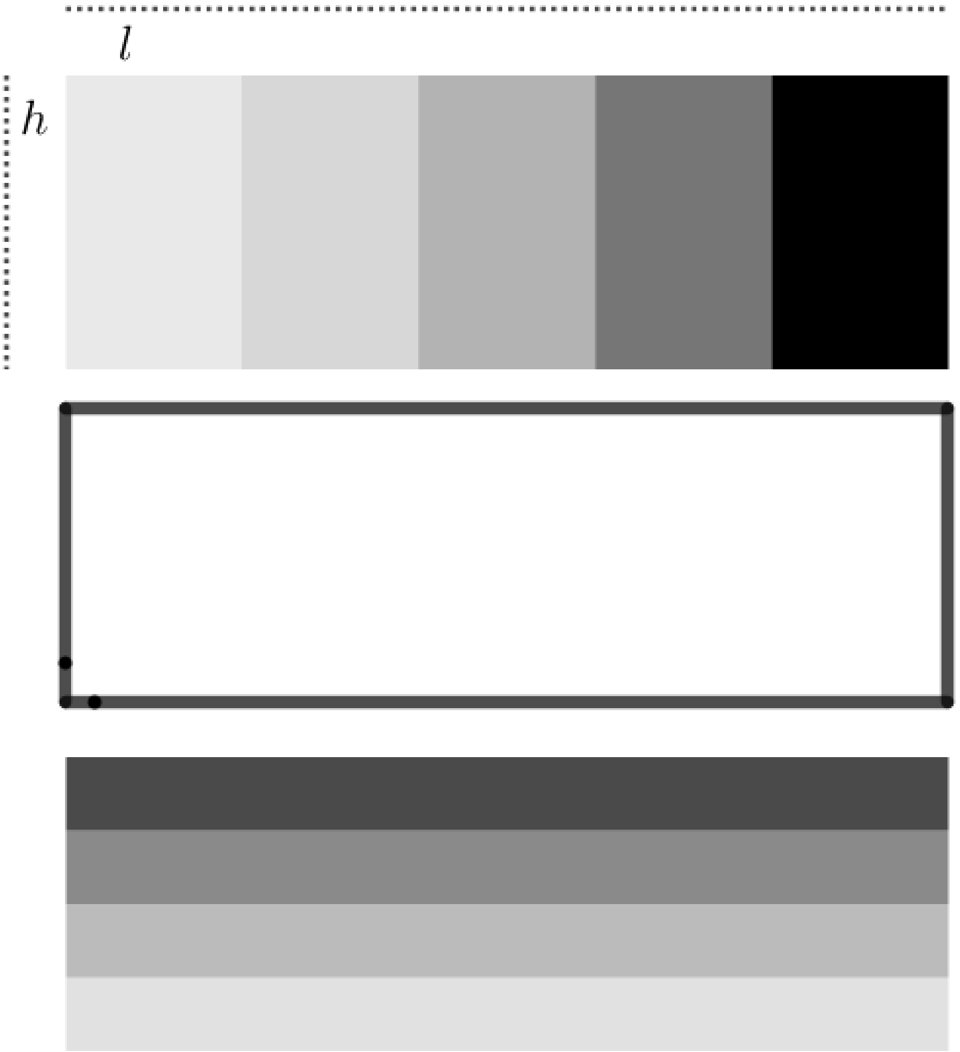
$$\frac{1}{R_{tot}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{3}{R}$$

$$R_{tot} = \frac{1}{3} R$$



$$R = \rho_R \cdot \frac{l}{A}$$

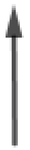
$$R = \rho \cdot \frac{l}{A}$$



$$\rho_{(x)} = \frac{\rho_0}{l} \cdot x$$

$$dR = \rho_{(x)} \cdot \frac{dx}{h}$$

$$R_{ser} = \int_0^l dR$$



$$dR = \rho_{(x)} \cdot \frac{h}{dx}$$

$$\frac{1}{R_{par}} = \int_0^l \frac{1}{dR}$$

$$\rho_{(y)} = \frac{\rho_0}{l} \cdot y$$

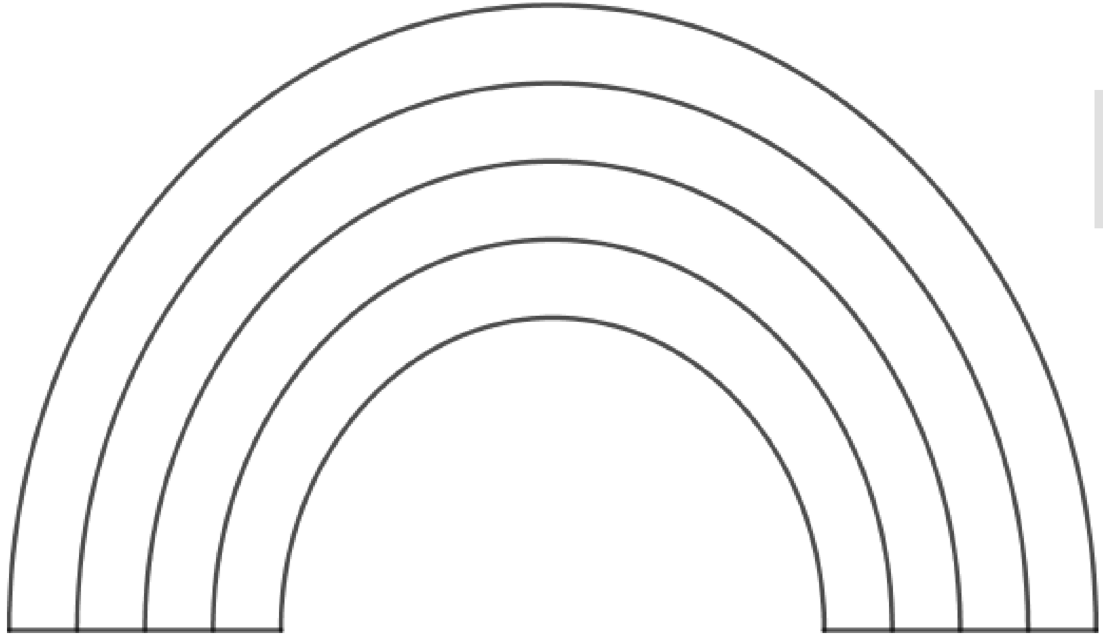
$$dR = \rho_{(y)} \cdot \frac{l}{dy}$$

$$\frac{1}{R_{par}} = \int_0^h \frac{1}{dR}$$

$$dR = \rho_{(y)} \cdot \frac{dy}{l}$$

$$R_{ser} = \int_0^h dR$$

$$R = \rho \frac{l}{A}$$



$$dR = \rho_0 \frac{dr}{\pi r}$$

$$dR = \rho_0 \frac{\pi r}{dr}$$

$$R_{ser} = \int dR$$

$$\frac{1}{R_{par}} = \int \frac{1}{dR}$$

$$R_{tot} = \frac{\rho_0}{\pi} \int_{R_A}^{R_B} \frac{1}{r} dr$$

$$\frac{1}{R_{tot}} = \frac{1}{\pi \rho_0} \int_{R_A}^{R_B} \frac{1}{r} dr$$

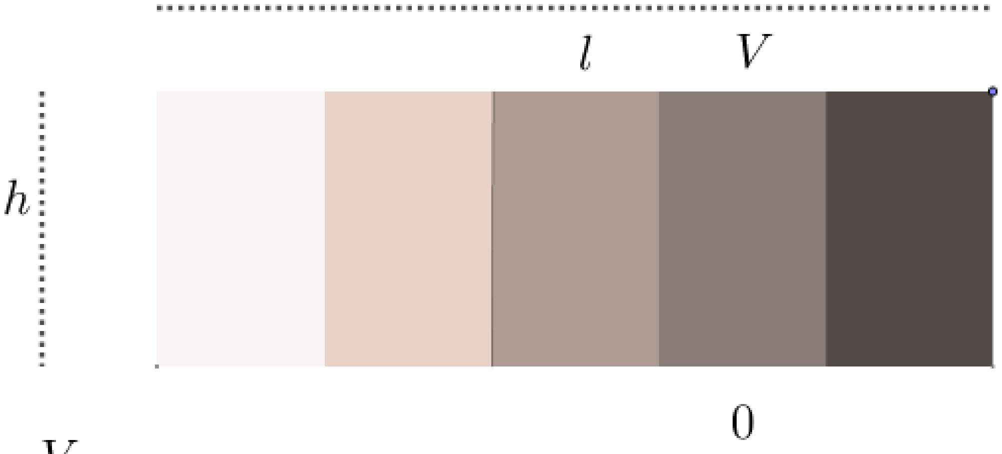
$$\boldsymbol{R_{tot} = \frac{\rho_0}{\pi} lan(\frac{R_B}{R_A})}$$

$$\boldsymbol{\frac{1}{R_{tot}} = \frac{1}{\pi \rho_0} lan(\frac{R_B}{R_A})}$$

$$\int J \cdot ds = I \quad \Rightarrow J = \frac{I}{A}$$

$$\frac{1}{\rho_R} = \sigma_R$$

$$\frac{V}{R} = I \Rightarrow \quad \frac{E}{\rho} = J$$



$$\frac{V}{l} = E \to \frac{E}{\rho_{R(x)}} = J \to \int J dx = I$$

$$\frac{1}{R_{par}} = \int_0^l \frac{1}{dR} \to \frac{V}{R} = I$$

$$\rho_{(x)} = \rho_0 (1 + \frac{x}{l})$$

$$I, J, \rho_V, \sigma_S, E = ?$$

$$\frac{1}{R_{tot}} = \int_0^l \frac{1}{\rho_{(x)} \cdot \frac{h}{dx}} = \frac{1}{h} \int_0^l \frac{1}{\rho_{(x)} \cdot \frac{1}{dx}} = \frac{1}{h} \int_0^l \frac{l}{\rho_0 \cdot (l + x)} dx$$

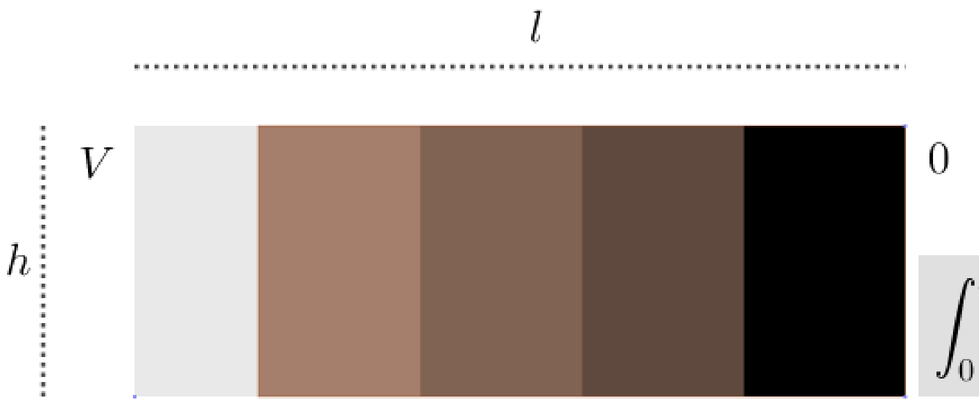
$$\frac{1}{R_{tot}} = lan(2) \frac{1}{h} \frac{l}{\rho_0}$$

$$\frac{V}{h} = E$$

$$\frac{\frac{V}{h}}{\frac{\rho_0}{l}(l+x)} = J$$

$$\boldsymbol{J = \frac{1}{h} \frac{l}{\rho_0} V \cdot \frac{1}{l + x}} \qquad \boldsymbol{I = lan(2) \frac{1}{h} \frac{l}{\rho_0} V}$$

$$\frac{1}{h} \frac{l}{\rho_0} V \int_0^l \frac{1}{l + x} \cdot dx = I = \frac{1}{h} \frac{l}{\rho_0} V \cdot [lan(2l) - lan(l)]$$



$$I, J, \rho_V, \sigma_S, E = ? \qquad \rho_{(x)} = \frac{\rho_0}{l} \cdot x$$

$$\int_0^l dR_{(x)} = R_{ser} \rightarrow \frac{V}{R} = I \rightarrow \frac{I}{x} = J \rightarrow J \cdot \rho_{R(x)} = E \rightarrow \nabla \vec{E} = \rho_{V(x)}$$

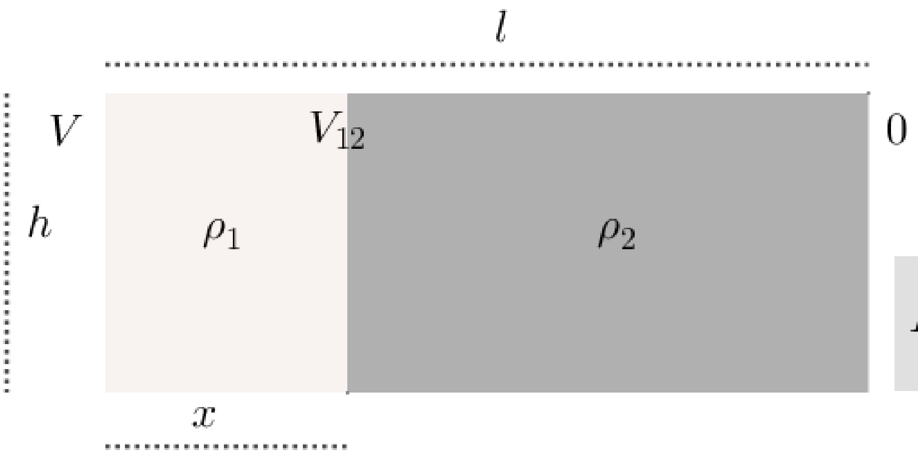
$$R_{tot} = \int_o^l (\frac{\rho_o}{l} \cdot x) \cdot \frac{dx}{h} = \frac{1}{2} \cdot \rho_0 \cdot \frac{l}{h}$$

$$\frac{V}{R_{tot}} = I \qquad \boldsymbol{I = V \cdot \frac{2h}{\rho_0 \cdot l}}$$

$$\frac{I}{h} = J$$

$$E = J \cdot \rho_R = \frac{I}{h} \cdot \frac{\rho_0}{l} \cdot x$$

$$\nabla E_{(x)} = \frac{dE}{dx} = \frac{I}{h} \cdot \frac{\rho_0}{l} \qquad \boldsymbol{\rho_{(x)} = 2\frac{V}{l^2}}$$



$$I, J, \rho_V, \sigma_S, E = ?$$

$$R_{ser} = \Sigma R_i \rightarrow \frac{V}{R} = I \rightarrow R_{1,2} \cdot I = V_{1,2} \rightarrow \frac{V_{1,2}}{x_{1,2}} = E_{1,2} \rightarrow \Delta \vec{E} = \sigma$$

$$R_{tot} = R_1 + R_2 = \rho_1 \cdot \frac{x}{h} + \rho_2 \cdot \frac{(l-x)}{h} = \frac{1}{h}[\rho_1 \cdot x + \rho_2 \cdot (l-x)]$$

$$\frac{V}{R_{tot}} = I = \boldsymbol{V \cdot \frac{h}{\rho_1 \cdot x + \rho_2 \cdot (l-x)}} \quad \boldsymbol{J = \frac{I}{h}}$$

$$\frac{V - V_{12}}{x} = \vec{E}_1$$

$$R_1 \cdot I = V_1$$

$$R_2 \cdot I = V_2$$

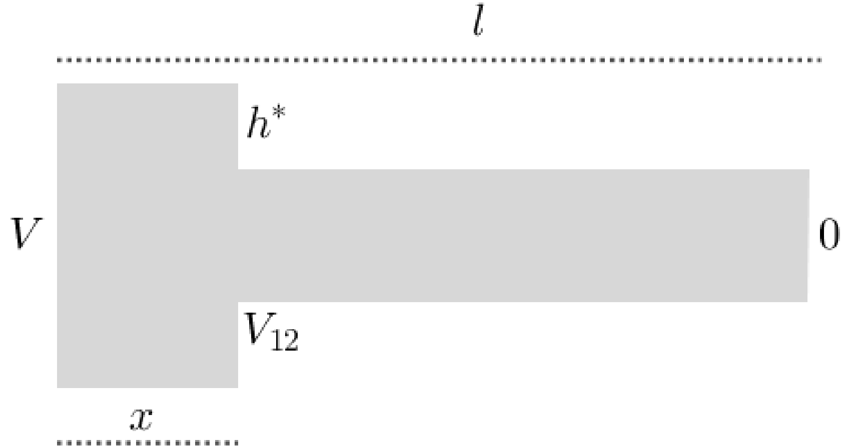
$$\frac{V_{12} - 0}{l - x} = \vec{E}_2$$

$$V - V_1 =_{or} \underline{V_{12}} =_{or} 0 + V_2$$

$$\vec{E}_2 - \vec{E}_1 = \sigma = \frac{V_{12} \cdot x - (V - V_{12})(l-x)}{x(l-x)}$$

$$\boldsymbol{V_{12} = V \cdot \frac{\rho_2 \cdot (l-x)}{\rho_1 \cdot x + \rho_2 \cdot (l-x)}}$$

$$\boldsymbol{\sigma = \frac{-Vl + V_{12}l + Vx}{x(l-x)}}$$



$$R_{ser} = \Sigma R_i \rightarrow \frac{V}{R} = I \rightarrow R_{1,2} \cdot I = V_{1,2} \rightarrow \frac{V_{1,2}}{x_{1,2}} = E_{1,2} \rightarrow \Delta \vec{E} = \sigma_S$$

$$I, J, \rho_V, \sigma_S, E = ?$$

$$R_{tot} = R_1 + R_2 = \rho_1 \cdot \frac{x}{h} + \rho_2 \cdot \frac{(l-x)}{h^*} = \rho(\frac{x}{h} + \frac{l-x}{h^*})$$

$$\frac{V}{R_{tot}} = I = \boldsymbol{V \cdot \frac{hh^*}{\rho \cdot [xh^* + (l-x)h]}}$$

$$R_1 \cdot I = V_1$$

$$R_2 \cdot I = V_2$$

$$V - V_1 =_{or} V_{12} =_{or} 0 + V_2$$

$$\boldsymbol{V_{12} = V \cdot \frac{h(l-x)}{xh^* + (l-x)h}}$$

$$\frac{V_1}{x} = \vec{E}_1$$

$$\frac{V_2}{l-x} = \vec{E}_2$$

$$E_2 - E_1 = \sigma$$

$$\boldsymbol{R_{tot} = \frac{\rho_0}{\pi} lan(\frac{R_B}{R_A})}$$

$$\vec{E}_I = \frac{1}{lan(\frac{b}{a})} \frac{V}{r}$$

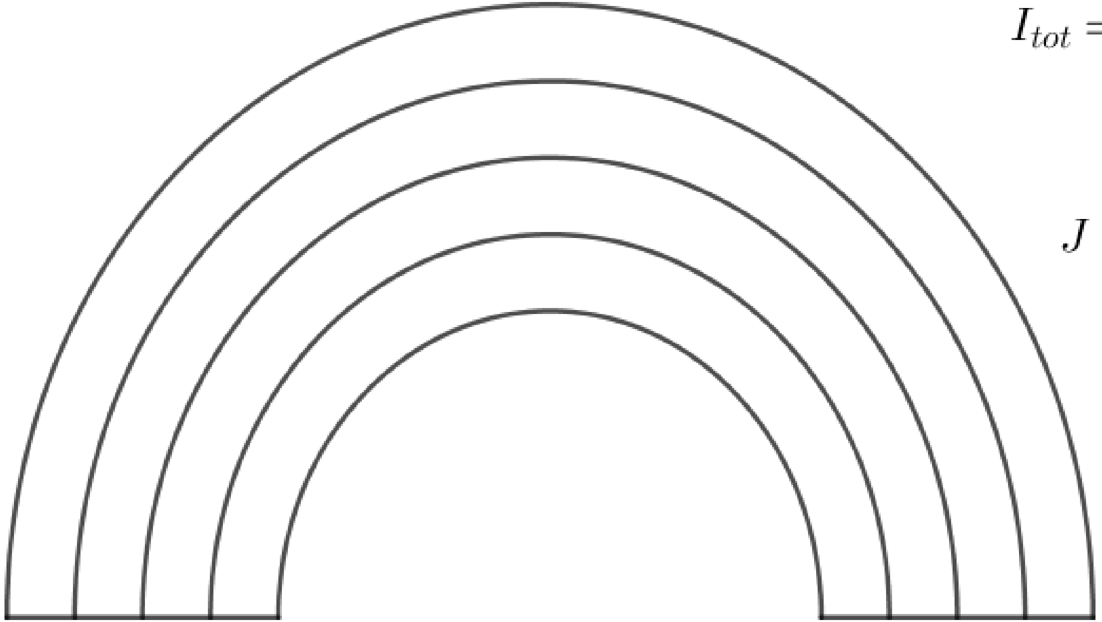
$$\frac{V}{R} = I$$

$$J = \frac{I}{A}$$

$$E = J\rho$$

$$\rho_V = \nabla \cdot E$$

$$\nabla \cdot E = \frac{1}{r} \frac{d(r \cdot \vec{E})}{dr}$$



$$I_{tot} = \frac{V}{\frac{\rho_0}{\pi} lan(\frac{R_B}{R_A})}$$

$$J = \frac{I}{\pi r} = \frac{V}{\frac{\rho_0}{\pi} lan(\frac{R_B}{R_A})} \frac{1}{\pi r} = \frac{1}{\rho_0 lan(\frac{R_B}{R_A})} \frac{V}{r}$$

$$E_I = \frac{1}{lan(\frac{R_B}{R_A})} \frac{V}{r}$$

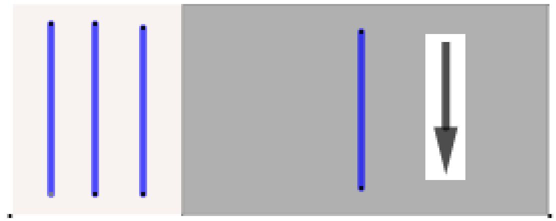
$$\nabla \cdot E = 0 \;\Rightarrow \rho_V = 0$$

$$\frac{V}{l} = E \rightarrow \frac{E}{\rho_{(x)}} = J_{(x)} \rightarrow \int J_{(x)} dx = I$$

$$\frac{1}{R_{par}} = \int_0^l \frac{1}{dR} \rightarrow \frac{V}{R} = I$$

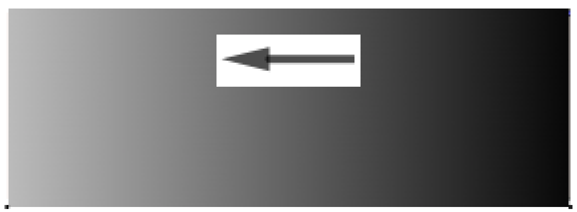
$$(\rho_{1,2} \frac{l}{A_{1,2}} = R_{1,2} \rightarrow) \frac{V}{R_{1,2}} = I_{1,2} \rightarrow \frac{I_{1,2}}{A_{1,2}} = J_{1,2}$$

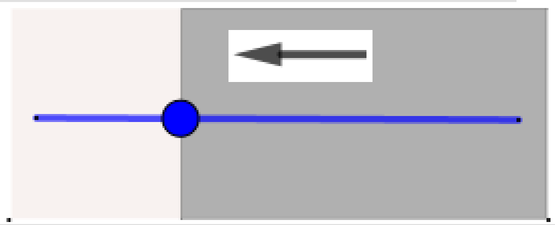
$$\frac{V}{l} = E \qquad \frac{E}{\rho_{1,2}} = J_{1,2} \qquad J_{1,2} \cdot A_{1,2} = I_{1,2} \qquad I_{tot} = I_1 + I_2$$



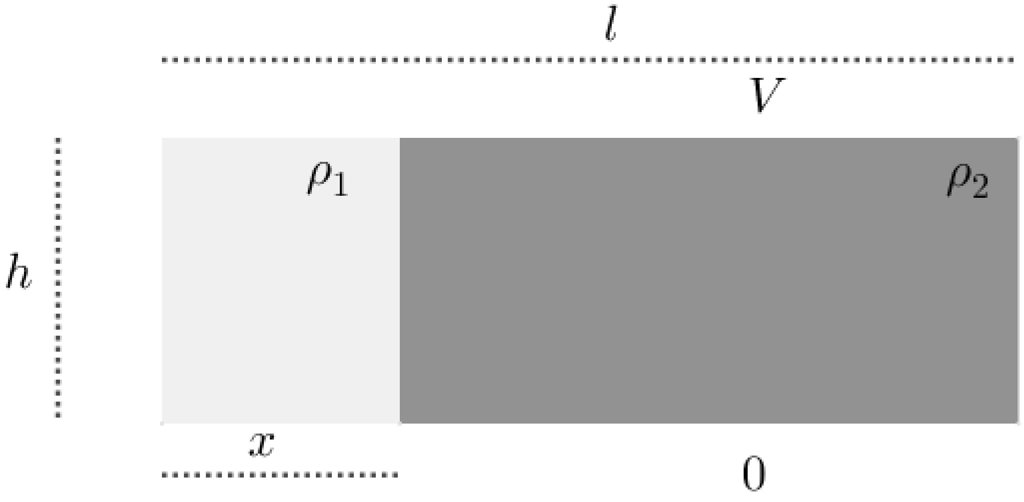
$$R, E, I, J, \sigma_S, \rho_V = ?$$

$$R_{ser} = \Sigma R_i \rightarrow \frac{V}{R} = I \rightarrow R_{1,2} \cdot I = V_{1,2} \rightarrow \frac{V_{1,2}}{x_{1,2}} = E_{1,2} \rightarrow \Delta \vec{E} = \sigma_S$$





$$\int_0^l dR_{(x)} = R_{ser} \rightarrow \frac{V}{R} = I \rightarrow \frac{I}{A} = J \rightarrow J \cdot \rho_{R(x)} = E_{(x)} \rightarrow \nabla \vec{E} = \rho_{V(x)}$$



$$I, J, \rho_V, \sigma_S, E = ?$$

$$\rho_{1,2}\frac{l}{x_{1,2}} = R_{1,2} \rightarrow \frac{V_{1,2}}{R_{1,2}} = I_{1,2} \rightarrow \frac{I_{1,2}}{A_{1,2}} = J_{1,2}$$

$$\frac{V}{l} = E \quad I_{tot} = I_1 + I_2$$

$$\rho_1\frac{h}{x} = R_1 \qquad \rho_2\frac{h}{l-x} = R_2 \qquad \frac{V}{h} = E$$

$$\frac{V}{R_1} = I_1 \qquad \frac{V}{R_2} = I_2 \qquad I = I_1 + I_2$$

$$J_1 = \frac{I_1}{x} \qquad J_2 = \frac{I_2}{l-x}$$