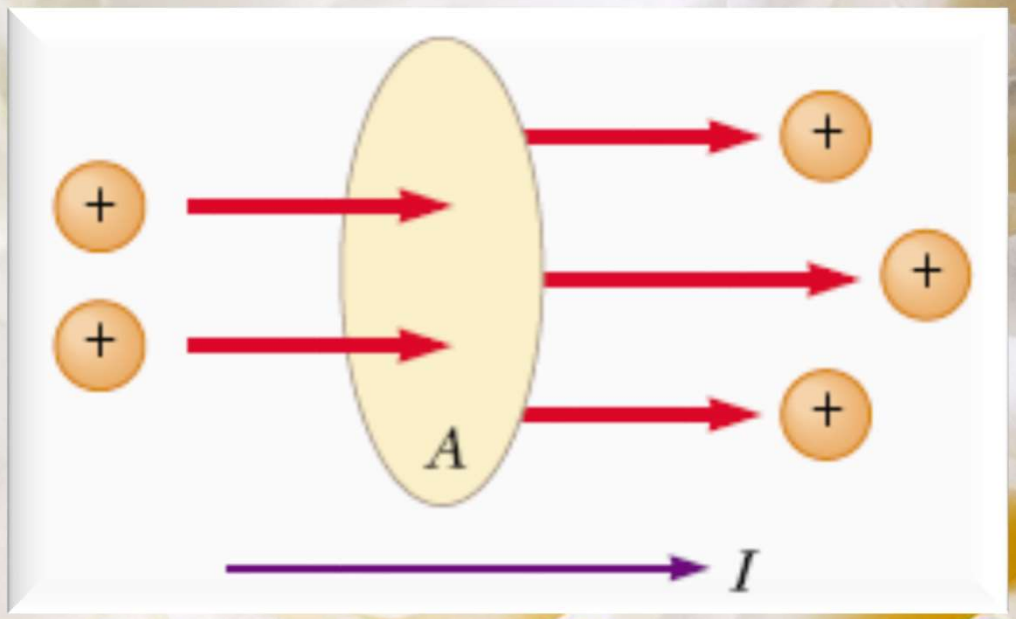
جریان و مقاومت

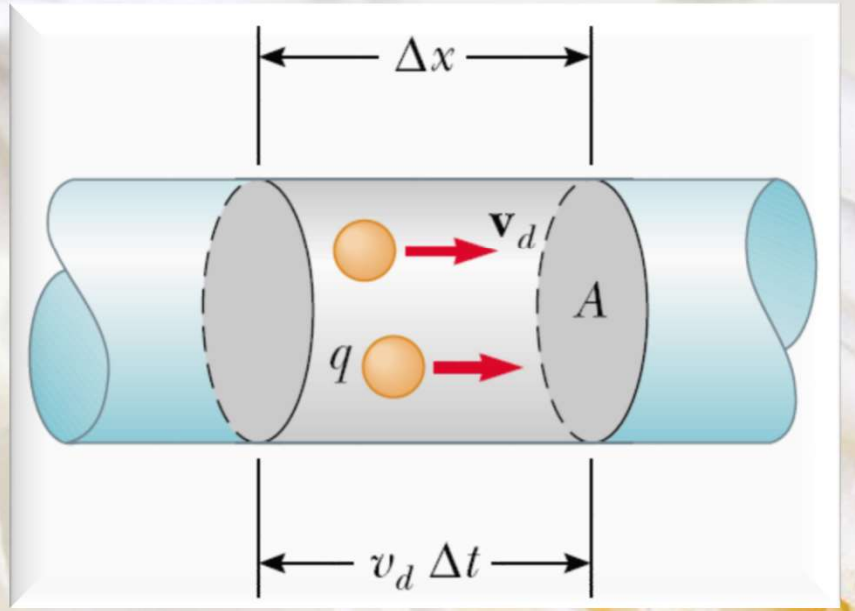
جریان الکتریکی

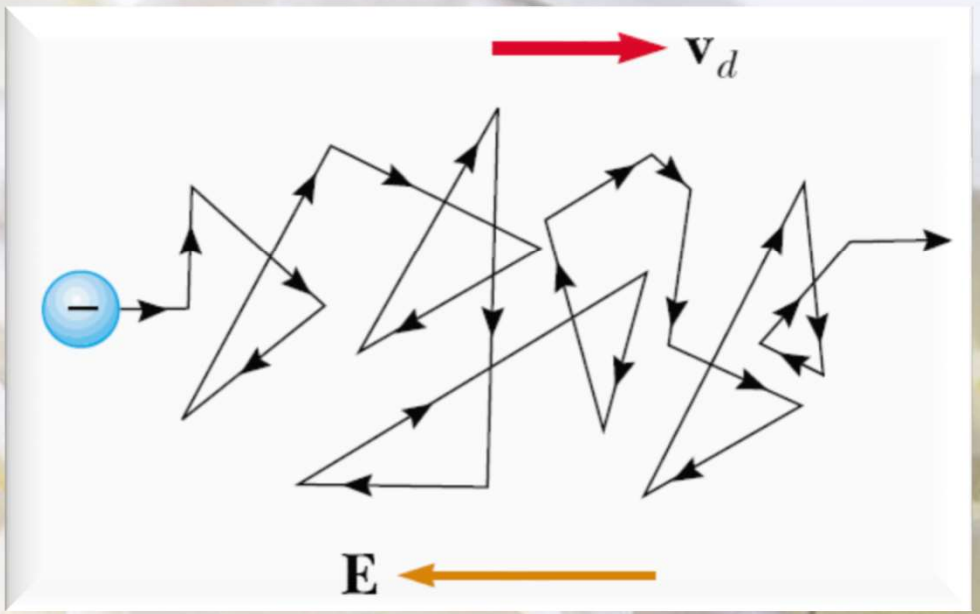


$$I_{av} = \frac{\Delta Q}{\Delta t}$$

$$I \equiv \frac{dQ}{dt}$$

$$1\ \mathrm{A} = \frac{1\ \mathrm{C}}{1\ \mathrm{s}}$$



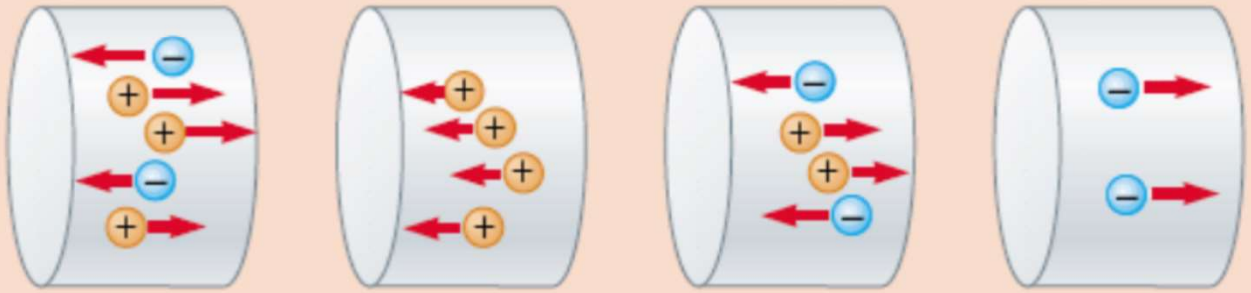


$$\Delta x = v_d\,\Delta t$$

$$\Delta Q = (nAv_d\,\Delta t)\,q$$

$$I_{\text{av}} = \frac{\Delta Q}{\Delta t} = nqv_dA$$

Quick Quiz 27.1 Consider positive and negative charges moving horizontally through the four regions shown in Figure 27.4. Rank the current in these four regions, from lowest to highest.



(a) (b) (c) (d)

d, b = c, a. The current in part (d) is equivalent to two positive charges moving to the left. Parts (b) and (c) each represent four positive charges moving in the same direction because negative charges moving to the left are equivalent to positive charges moving to the right. The current in part (a) is equivalent to five positive charges moving to the right.

مقاومت الکتریکی

$$I = nqv_d A$$

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

$$\mathbf{J} = nq\mathbf{v}_d$$

$$\mathbf{J} = \sigma\mathbf{E}$$

Georg Simon Ohm

German physicist (1789–1854)

$$\Delta V = V_b - V_a$$

$$\Delta V = E\ell$$

$$J = \sigma E = \sigma \frac{\Delta V}{\ell}$$

$$J = I/A$$

$$\Delta V = \frac{\ell}{\sigma} J = \left(\frac{\ell}{\sigma A}\right) I = RI$$

$$R = \ell/\sigma A$$

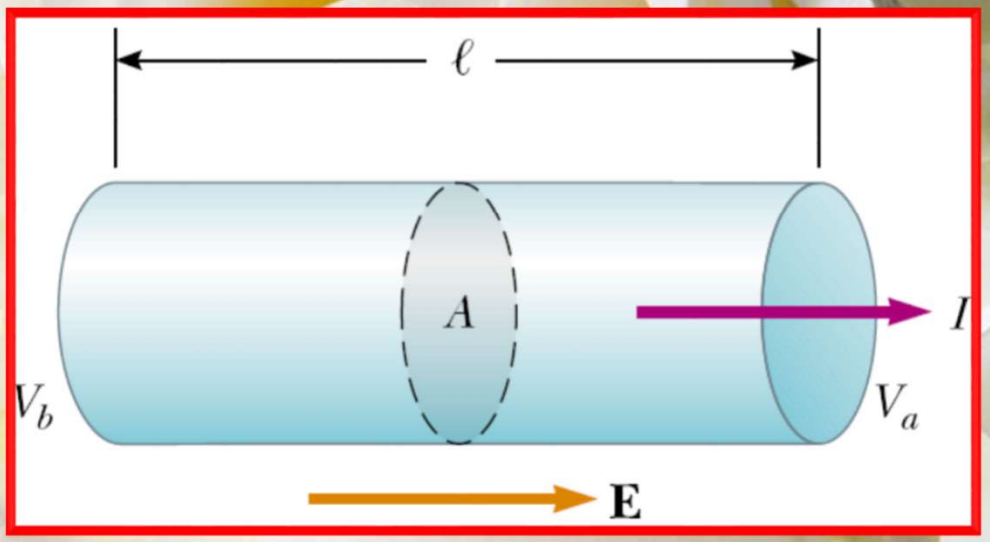
$$R \equiv \frac{\Delta V}{I}$$

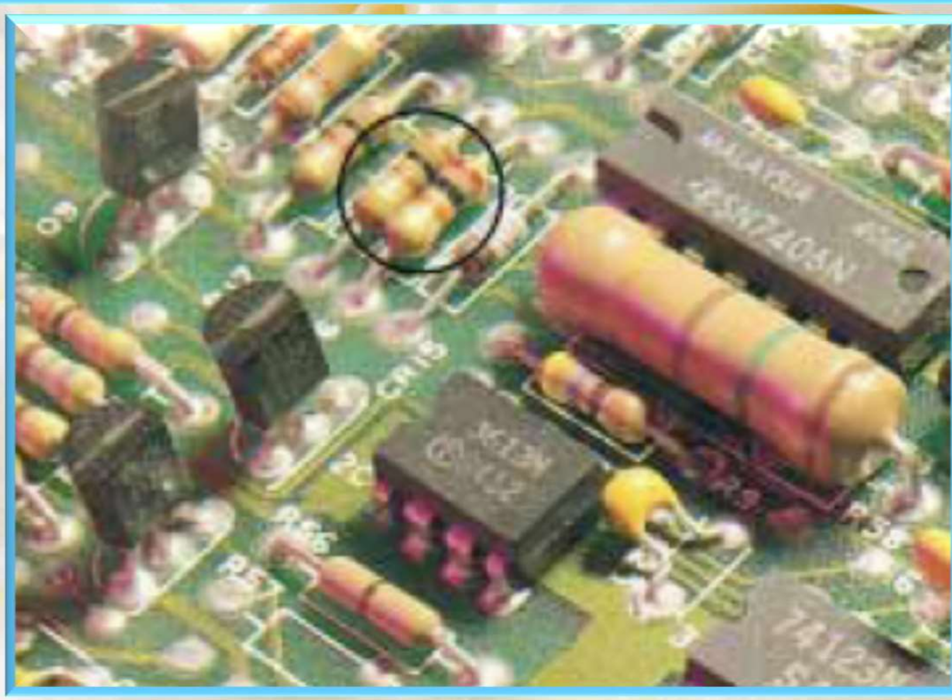
$$1\ \Omega \equiv \frac{1\ \text{V}}{1\ \text{A}}$$

$$V_b - V_a = -\int_a^b \mathbf{E} \cdot d\mathbf{s} = E\int_0^\ell dx = E\ell$$

$$\rho = \frac{1}{\sigma}$$

$$R = \ell/\sigma A$$

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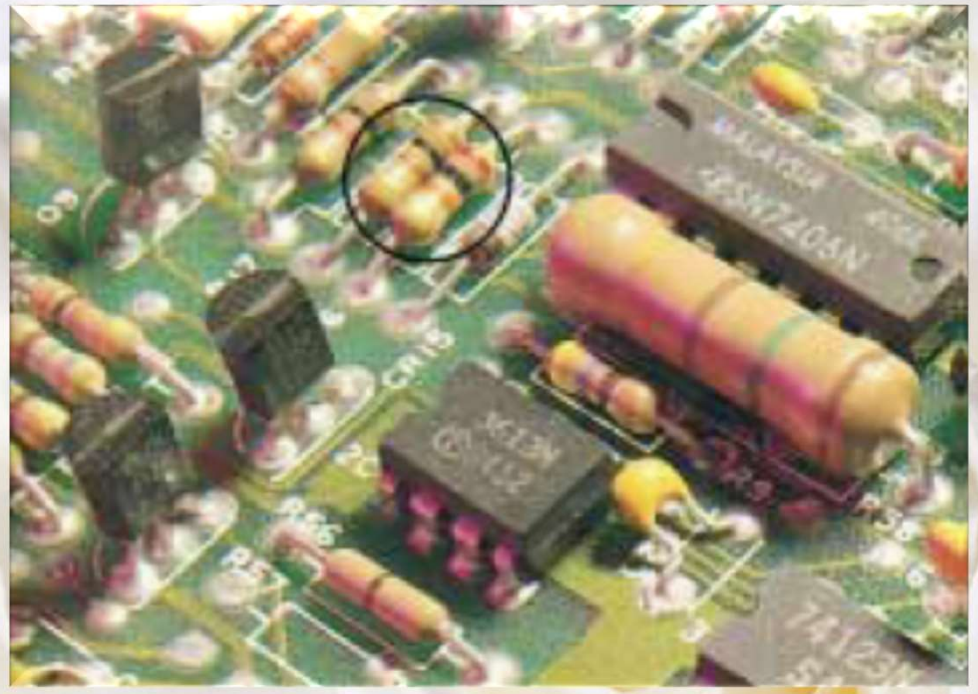
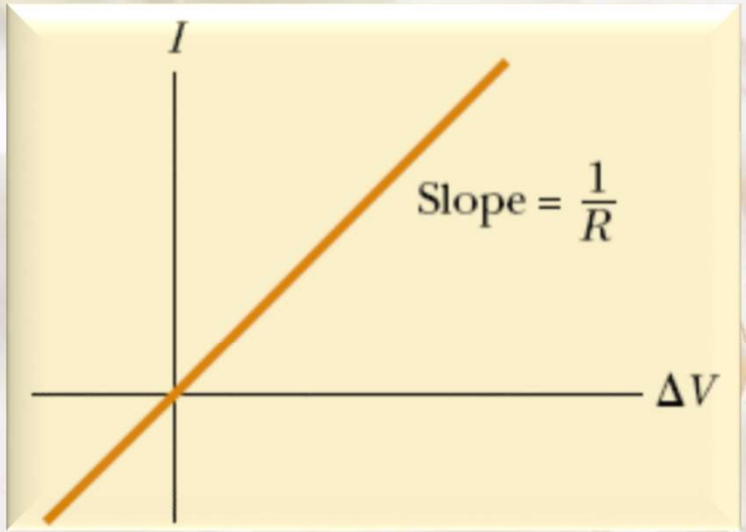
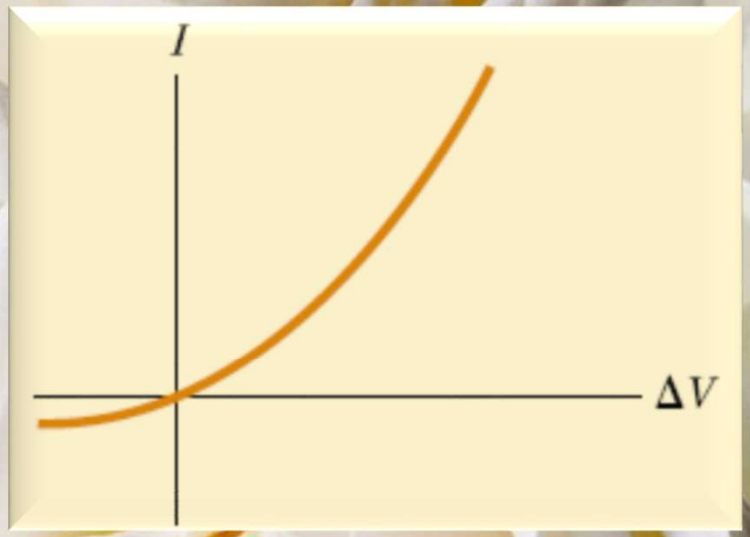


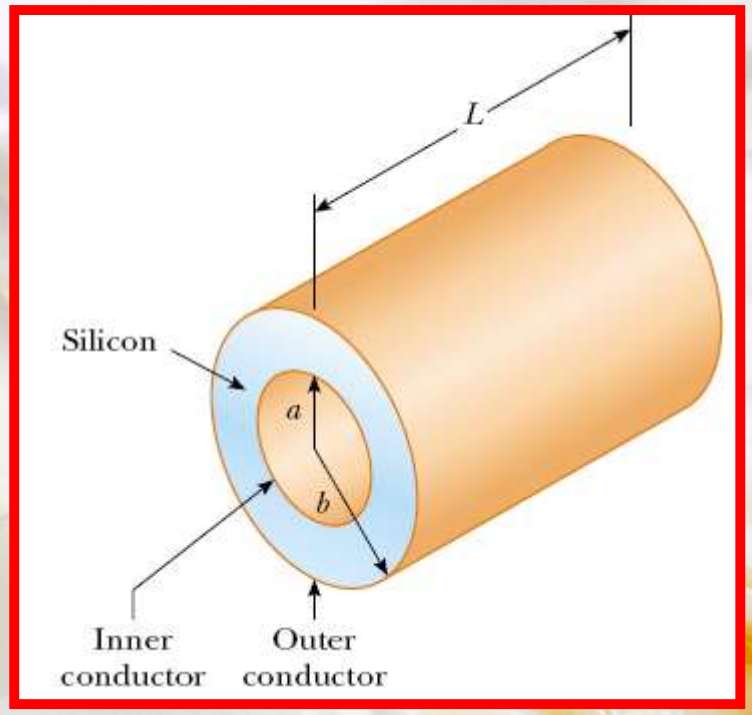
Figure 27.6 The colored bands on a resistor represent a code for determining resistance. The first two colors give the first two digits in the resistance value. The third color represents the power of ten for the multiplier of the resistance value. The last color is the tolerance of the resistance value. As an example, the four colors on the circled resistors are red (= 2), black (= 0), orange ($= 10^3$), and gold (= 5%), and so the resistance value is $20 \times 10^3\ \Omega = 20\ \text{k}\Omega$ with a tolerance value of 5% = 1 kΩ. (The values for the colors are from Table 27.2.)

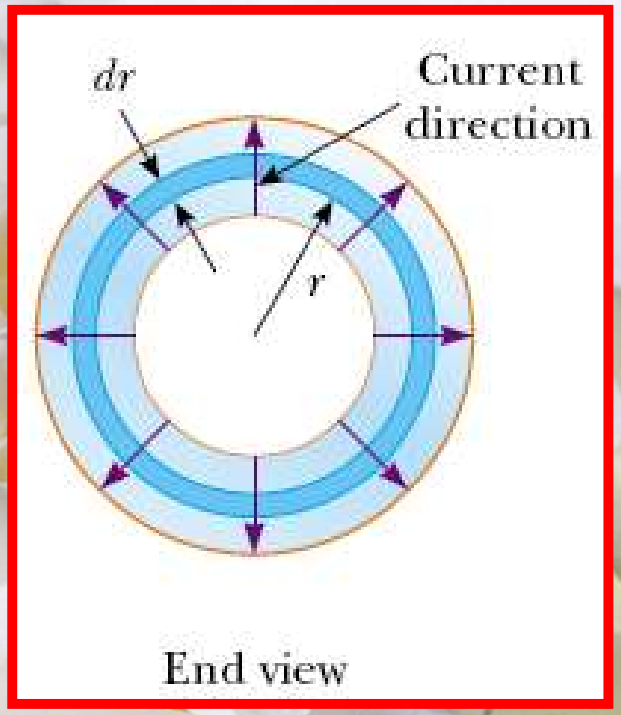
Color Coding for Resistors

Color	Number	Multiplier	Tolerance
Black	0	1	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		10^{-1}	5%
Silver		10^{-2}	10%
Colorless			20%


I
Slope = $\frac{1}{R}$
ΔV


I
ΔV

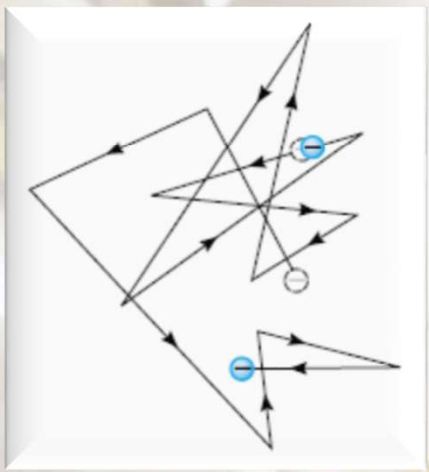


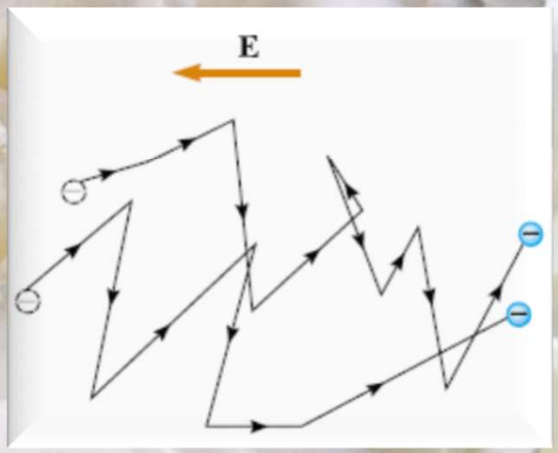


$$dR = \frac{\rho}{2\pi r L}\, dr$$

$$R = \int_a^b dR = \frac{\rho}{2\pi L}\int_a^b \frac{dr}{r} = \frac{\rho}{2\pi L}\ln\left(\frac{b}{a}\right)$$

یک مدل برای هدایت الکتریکی در فلزات





$$\mathbf{a} = \frac{q\mathbf{E}}{m_e}$$

$$J = nqv_d = \frac{nq^2E}{m_e}\,\tau$$

$$\mathbf{v}_f = \mathbf{v}_i + \mathbf{a}t = \mathbf{v}_i + \frac{q\mathbf{E}}{m_e}\,t$$

$$\sigma = \frac{nq^2\tau}{m_e}$$

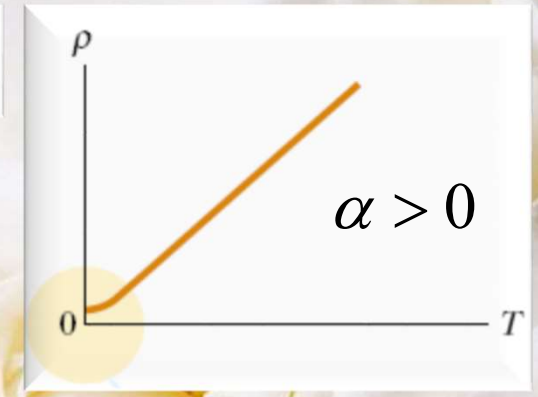
$$\rho = \frac{1}{\sigma} = \frac{m_e}{nq^2\tau}$$

$$\overline{\mathbf{v}}_f = \mathbf{v}_d = \frac{q\mathbf{E}}{m_e}\,\tau$$

$$\tau = \frac{\ell}{\overline{v}}$$

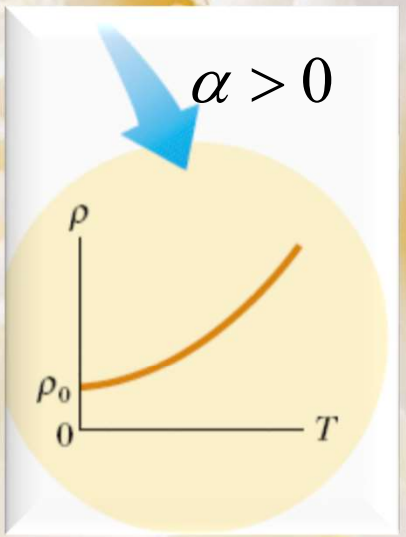
مقاومت و دما

$$\rho = \rho_0[1 + \alpha(T - T_0)]$$



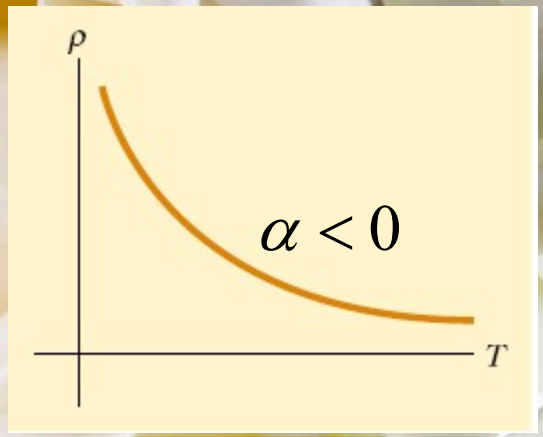
Metal

$$\alpha = \frac{1}{\rho_0}\frac{\Delta\rho}{\Delta T}$$



Metal

Semiconductor

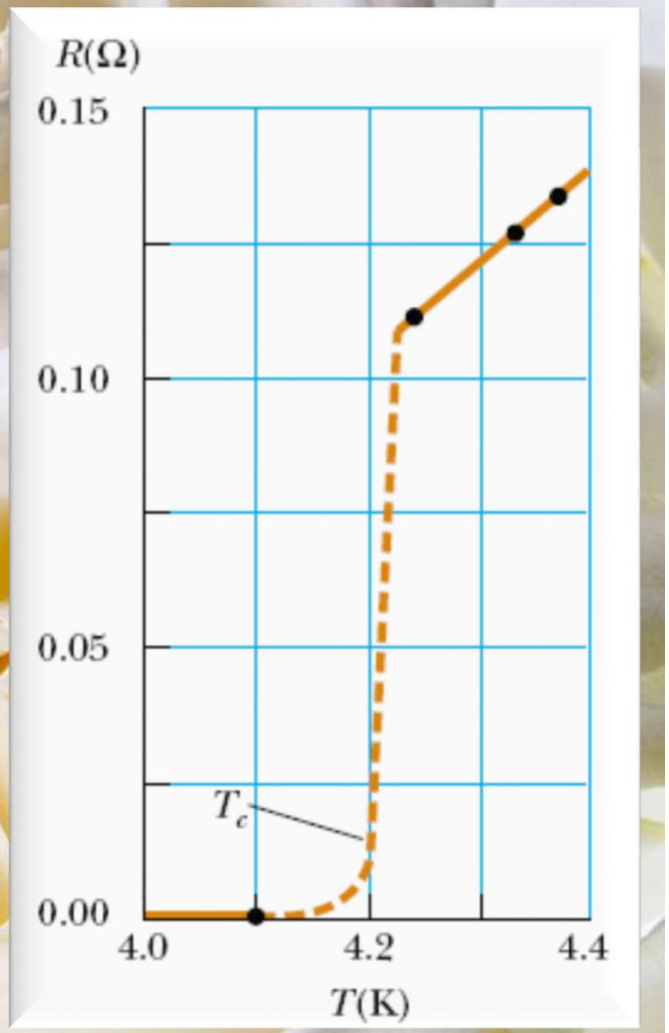


$$R = R_0[1 + \alpha(T - T_0)]$$

ابررسانایی

Critical Temperatures for Various Superconductors

Material	T_c(K)
$HgBa_2Ca_2Cu_3O_8$	134
Tl–Ba–Ca–Cu–O	125
Bi–Sr–Ca–Cu–O	105
$YBa_2Cu_3O_7$	92
Nb_3Ge	23.2
Nb_3Sn	18.05
Nb	9.46
Pb	7.18
Hg	4.15
Sn	3.72
Al	1.19
Zn	0.88




SAMSUNG


SAMSUNG


SONY
HD
SONY

توان الکتریکی

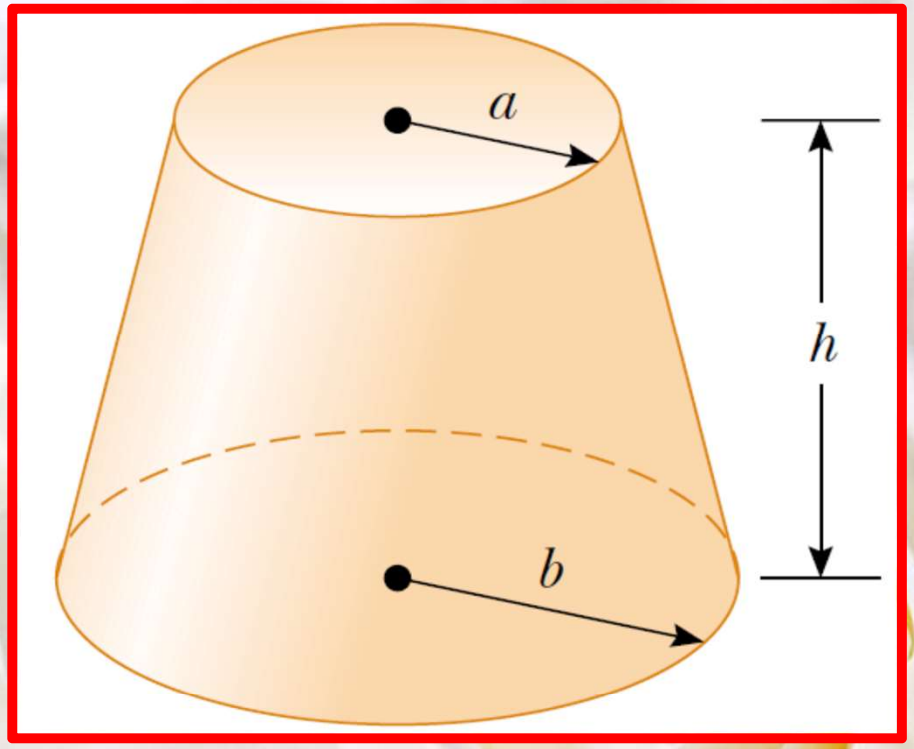
$$\frac{dU}{dt} = \frac{d}{dt}(Q\,\Delta V) = \frac{dQ}{dt}\,\Delta V = I\,\Delta V$$

$$\mathcal{P} = I\,\Delta V$$

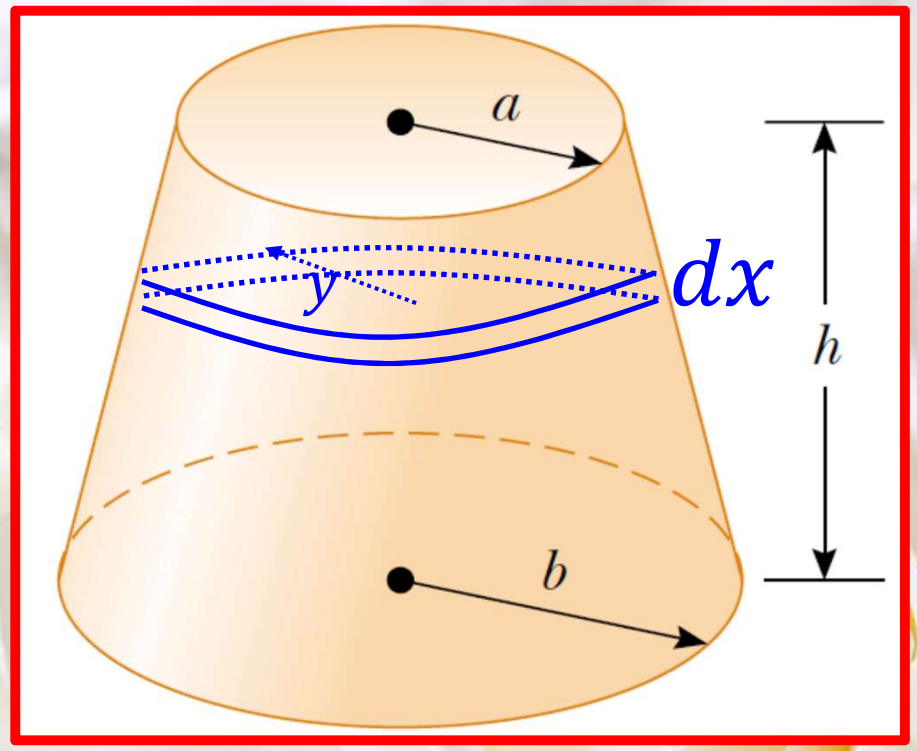
$$\Delta V = IR$$

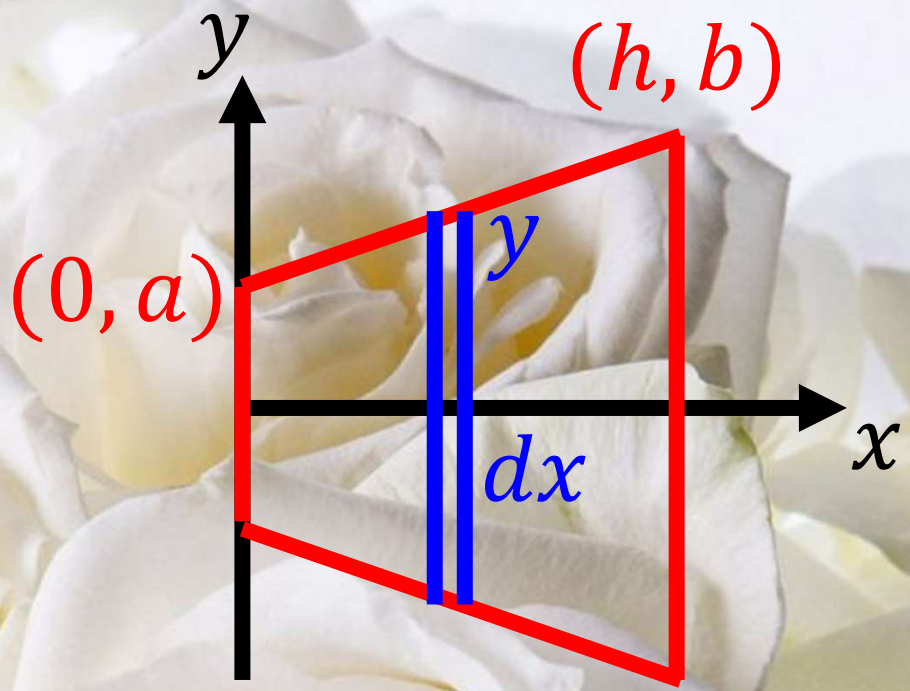
$$\mathcal{P} = I^2R = \frac{(\Delta V)^2}{R}$$

تمرین: نشان دهید که مقاومت الکتریکی سیم زیر به شکل یک مخروط ناقص از رابطه زیر به دست می آید:



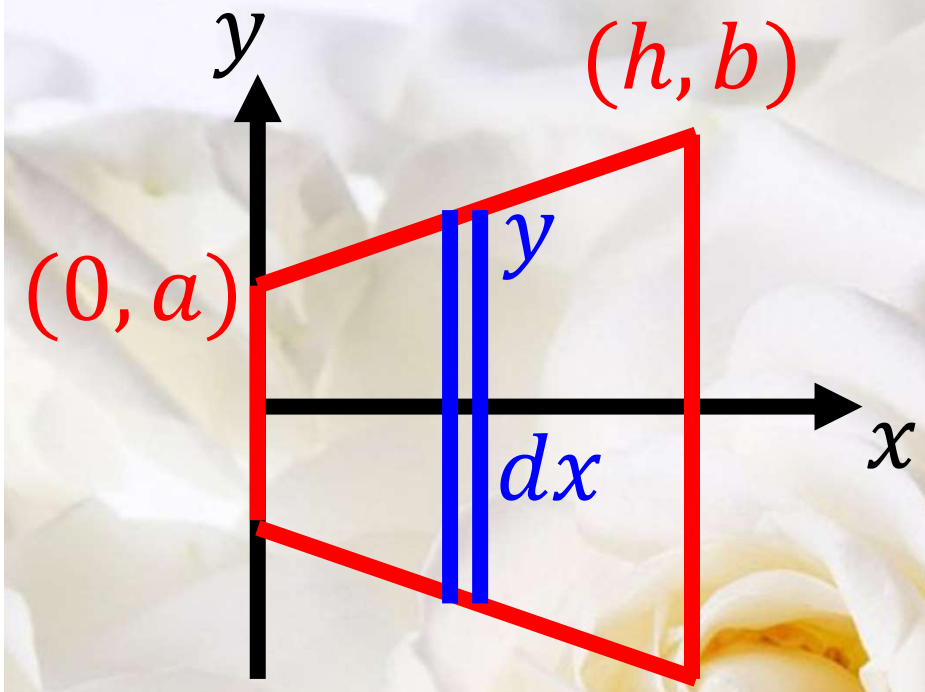
$$R = \frac{\rho}{\pi}\left(\frac{h}{ab}\right)$$





$$dR = \frac{\rho dx}{A}$$

$$A = \pi y^2$$



$$\frac{x-0}{h-0}=\frac{y-a}{b-a}$$

$$y=\frac{b-a}{h}x+a$$

$$dR=\frac{\rho dx}{\pi\left(\frac{b-a}{h}x+a\right)^2}$$

$$dR=\frac{\rho dx}{A}$$

$$R=\int_0^h \frac{\rho dx}{\pi\left(\frac{b-a}{h}x+a\right)^2}$$

$$A=\pi y^2$$

$$dR=\frac{\rho dx}{\pi y^2}$$

$$R=\frac{\rho}{\pi}\int_0^h \frac{dx}{\left(\frac{b-a}{h}x+a\right)^2}$$

$$R = \frac{\rho}{\pi}\int_0^h \frac{dx}{\left(\frac{b-a}{h}x + a\right)^2}$$

$$R = -\frac{\rho}{\pi}\frac{h}{b-a}\left(\frac{1}{\frac{b-a}{h}x + a}\right)_0^h$$

$$\frac{b-a}{h}x + a = u$$

$$R = -\frac{\rho}{\pi}\frac{h}{b-a}\left(\frac{1}{b} - \frac{1}{a}\right)$$

$$\frac{b-a}{h}dx = du$$

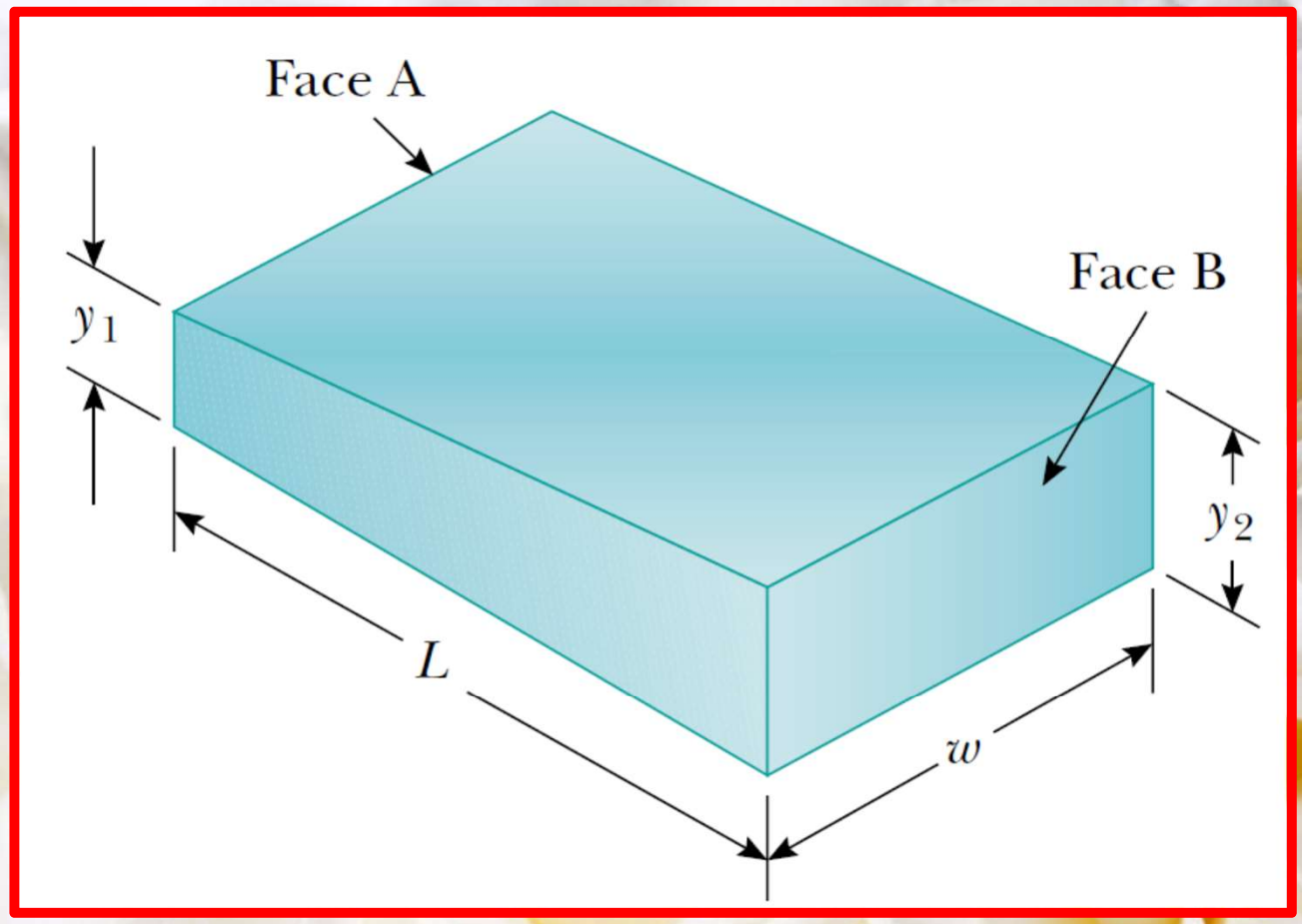
$$R = -\frac{\rho}{\pi}\frac{h}{b-a}\left(\frac{a-b}{ab}\right)$$

$$R = \frac{\rho}{\pi}\frac{h}{b-a}\int \frac{du}{u^2}$$

$$R = \frac{\rho}{\pi}\frac{h}{b-a}\left(\frac{b-a}{ab}\right)$$

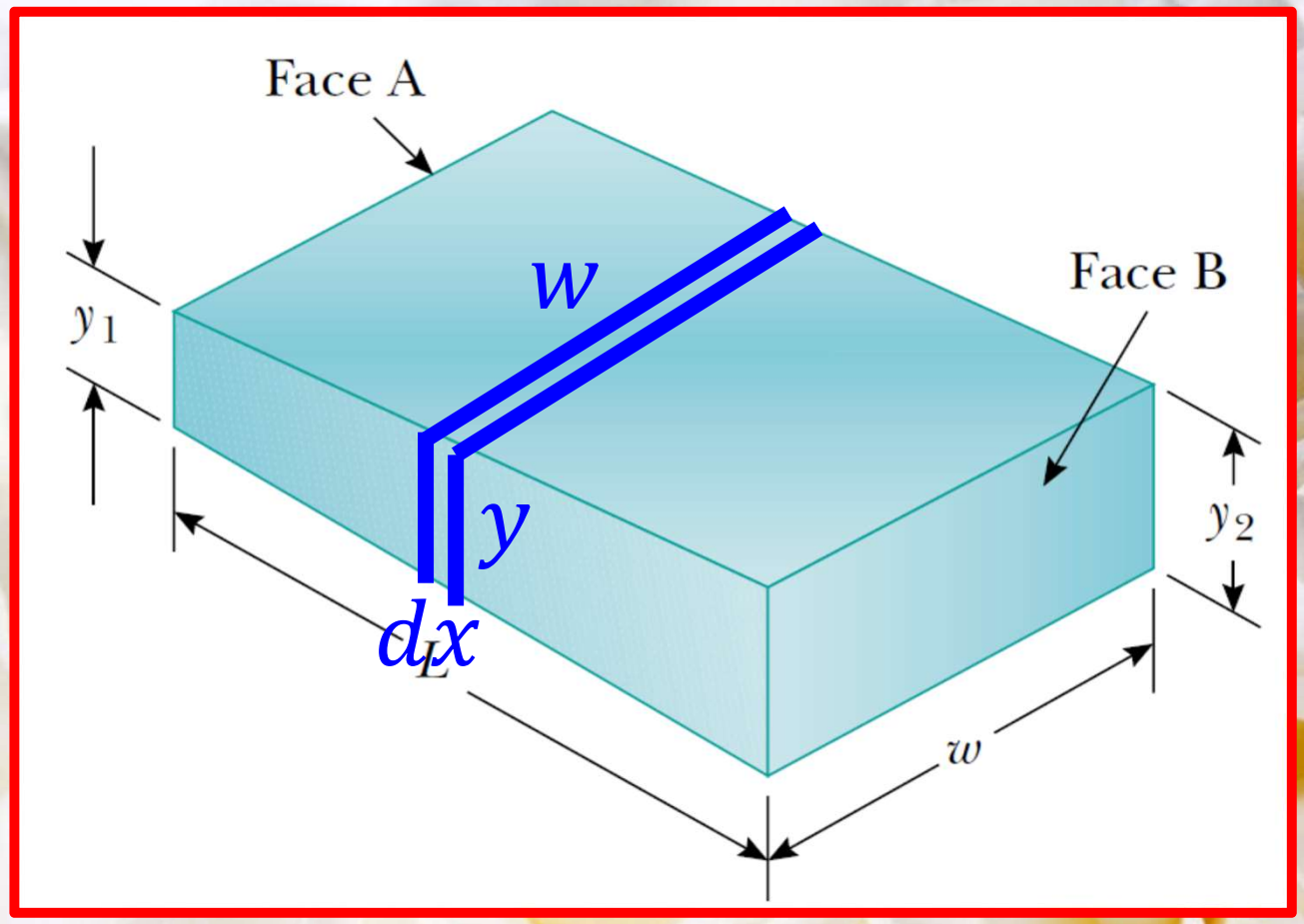
$$R = \frac{\rho}{\pi}\frac{h}{b-a}\left(-\frac{1}{u}\right)$$

$$R = \frac{\rho}{\pi}\frac{h}{ab}$$



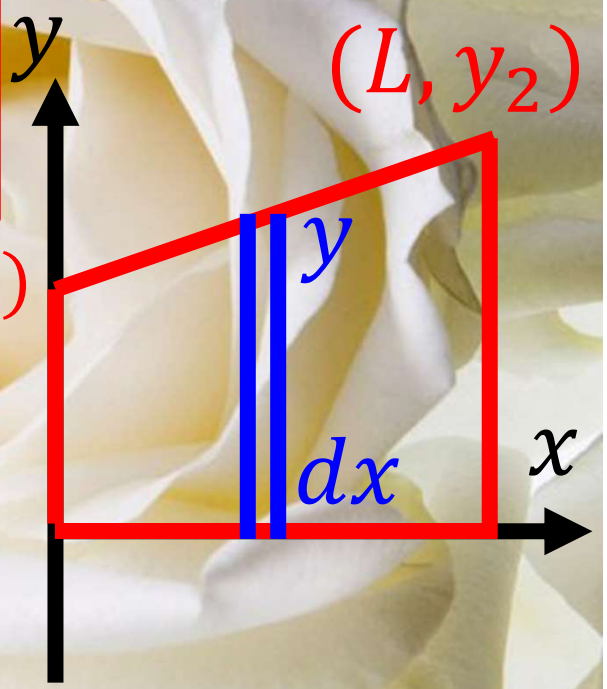
تمرین: نشان دهید که مقاومت الکتریکی سیم به شکل زیر از رابطه زیر به دست می آید:

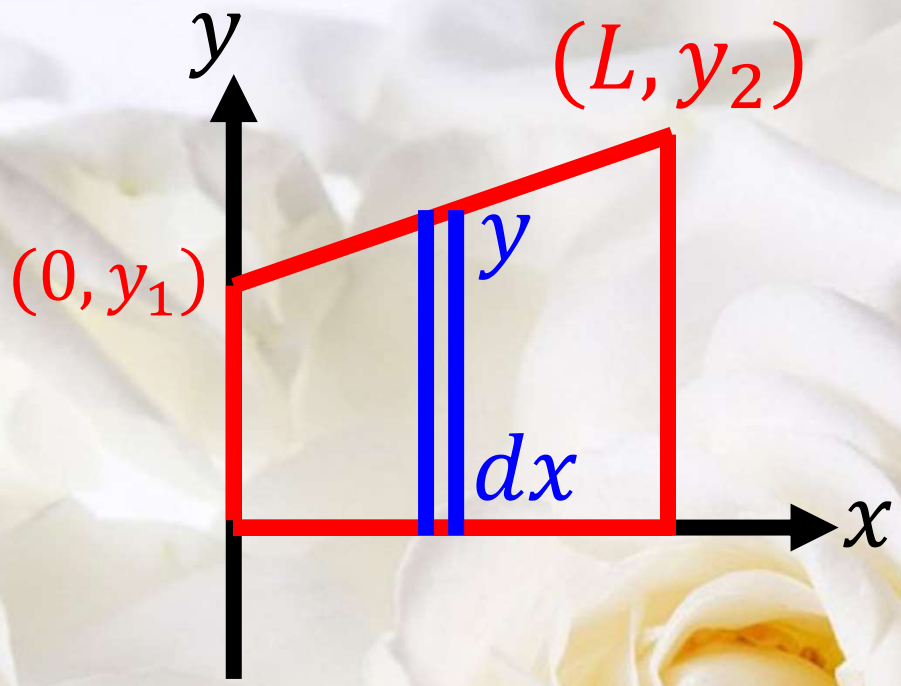
$$R = \rho \frac{L}{w(y_2 - y_1)} \ln\left(\frac{y_2}{y_1}\right)$$



$$dR = \frac{\rho dx}{A}$$

$$A = wy$$





$$\frac{x-0}{L-0} = \frac{y-y_1}{y_2-y_1}$$

$$y = \frac{y_2-y_1}{L}x + y_1$$

$$dR = \frac{\rho dx}{w\left(\frac{y_2-y_1}{L}x + y_1\right)}$$

$$dR = \frac{\rho dx}{A}$$

$$A = wy$$

$$dR = \frac{\rho dx}{wy}$$

$$R = \int_0^L \frac{\rho dx}{w\left(\frac{y_2-y_1}{L}x + y_1\right)}$$

$$R = \frac{\rho}{w}\int_0^L \frac{dx}{\frac{y_2-y_1}{L}x + y_1}$$

$$\frac{y_2 - y_1}{L} x + y_1 = u$$

$$R = \frac{\rho}{w} \frac{L}{y_2 - y_1} \left[\ln \left(\frac{y_2 - y_1}{L} x + y_1 \right) \right]_0^L$$

$$\frac{y_2 - y_1}{L} dx = du$$

$$R = \frac{\rho}{w} \frac{L}{y_2 - y_1} [\ln y_2 - \ln y_1]$$

$$R = \frac{\rho}{w} \frac{L}{y_2 - y_1} \int \frac{du}{u}$$

$$R = \frac{\rho}{w} \frac{L}{y_2 - y_1} \left[\ln \frac{y_2}{y_1} \right]$$

$$R = \frac{\rho}{w} \frac{L}{y_2 - y_1} \ln u$$