FISICA 1 (PALEONTOLOGÍA)

2DO CUATRIMESTRE 2020

CLASE 17

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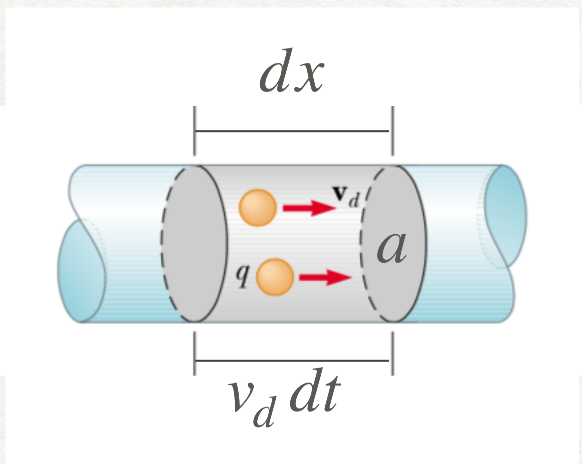
CLASE 17: Circuitos

Temas: Corriente eléctrica, resistencia, ley de Ohm.

corriente eléctrica: ~flujo de carga a través de un area

$$I \equiv \frac{dq}{dt}$$ *(dirección de una carga positiva)*

$$1A \equiv \frac{1\,C}{1\,s}$$ Ampere



$$dq = (n\,a\,dx)\,q$$
$$= (n\,a\,v_d\,dt)\,q$$
$$I = \frac{dq}{dt} = nav_dq$$

n número de portadores de carga por unidad de volumen

q carga de los portadores

v_d velocidad de deriva

ejemplo: cable de cobre de $a = 1\,mm^2$ *lleva* $10\,A$

$$\rho_{Cu} = 8.95\,g/cm^3$$
$$m_{Cu} = 63.5\,g/mol$$

$$V = \frac{m_{Cu}}{\rho_{Cu}} = 7.09\,cm^3$$

$$n_{Cu} = \frac{6.02 \times 10^{23}\,e^-}{7.09 \times 10^{-6}\,m^3} = 8.48 \times 10^{28}\,e^-/m^3$$

$$v_d = \frac{I}{naq} = \frac{10\,C/s}{(8.48 \times 10^{28}\,m^{-3})\,(10^{-6}\,m^2)(1.6 \times 10^{-19}\,C)} = 0.737\,mm/s$$

$$n_d = n_e\,v_d\,a = (8.48 \times 10^{28}\,e^-)\,(0.737 \times 10^{-3}/s)\,(1 \times 10^{-6}) = 6.25 \times 10^{19}\,e^-/s$$

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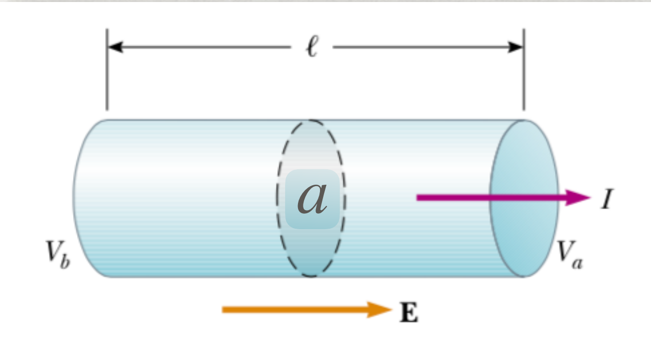
densidad de corriente eléctrica: ~corriente (flujo de carga) por unidad de área

$$J \equiv \frac{I}{a} = \frac{nav_d q}{a} = nv_d q \qquad \mathbf{J} = n\mathbf{v_d} q$$

$\mathbf{J}$ *requiere un campo:* $\mathbf{J} = \sigma \mathbf{E}$ $\quad \sigma$ *conductividad* *(depende de la naturaleza del conductor)*

$\sigma = \sigma(E)$? para la mayoría de los metales $\sigma = cte$ ley de Ohm

Georg Simon Ohm (1787 – 1854)



$$\Delta V = V_b - V_a = E\,l$$

$$J = \sigma E = \sigma \frac{\Delta V}{l} = \frac{I}{a} \qquad \Delta V = I\,\frac{l}{\sigma\,a} = IR$$

R *resistencia*

$\rho \equiv \dfrac{1}{\sigma}$ *resistividad* $\qquad R = \rho\,\dfrac{l}{a} \qquad 1\,\Omega = \dfrac{1\,V}{1\,A}$

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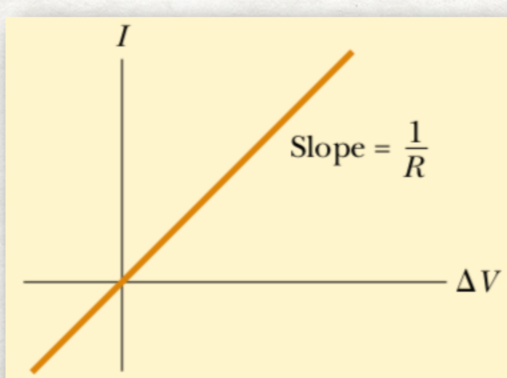
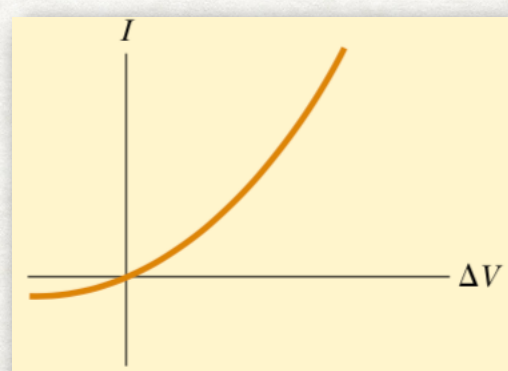
Material	Resistivity[a] ($\Omega \cdot m$)
Silver	1.59×10^{-8}
Copper	1.7×10^{-8}
Gold	2.44×10^{-8}
Aluminum	2.82×10^{-8}
Tungsten	5.6×10^{-8}
Iron	10×10^{-8}
Platinum	11×10^{-8}
Lead	22×10^{-8}
Nichrome[b]	1.50×10^{-6}
Carbon	3.5×10^{-5}
Germanium	0.46
Silicon	640
Glass	10^{10} to 10^{14}
Hard rubber	$\approx 10^{13}$
Sulfur	10^{15}
Quartz (fused)	75×10^{16}

$$\Delta V = I R$$

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



ohmico



no-ohmico

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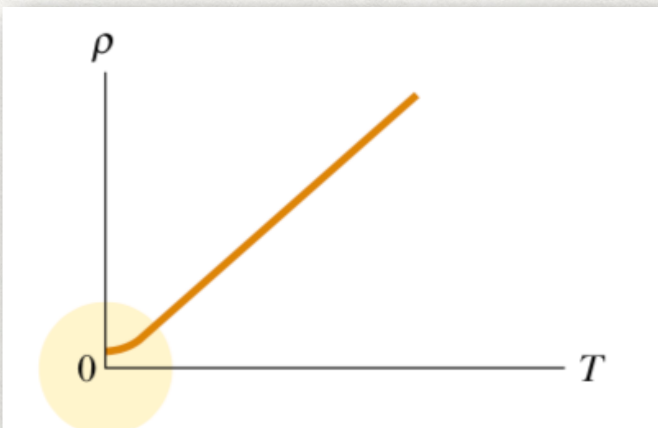
resistencia y temperatura:

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

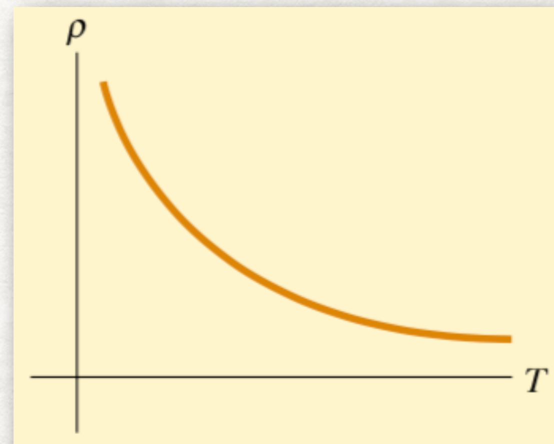
$$R(T) = R_0\,[1 + \alpha(T - T_0)]$$

ρ_0 resistividad a T_0

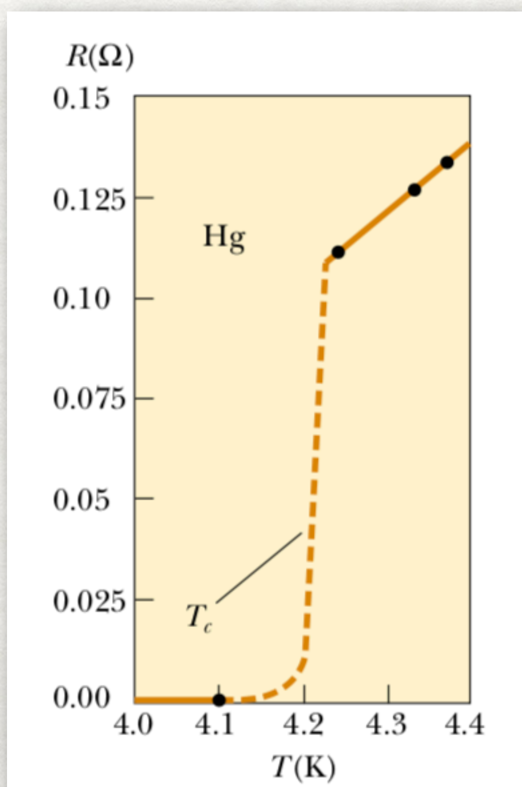
α coeficiente de temperatura $\sim 4 \cdot 10^{-3}\ {}^0C^{-1}$



metales

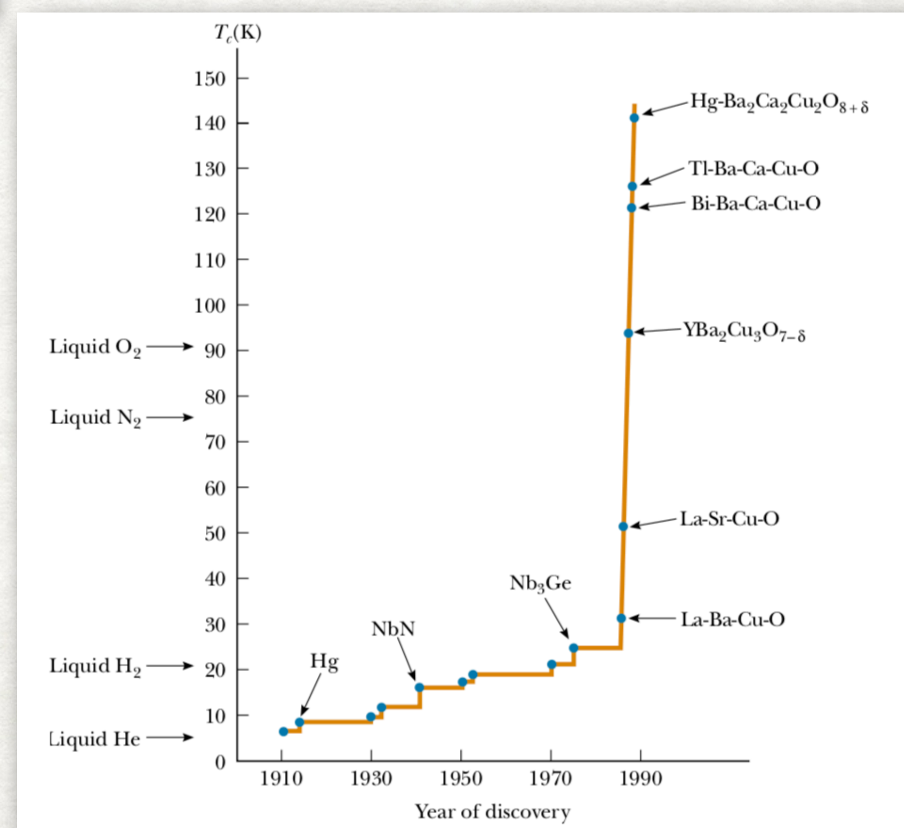


semi-conductores: silicio, germanio



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

superconductores



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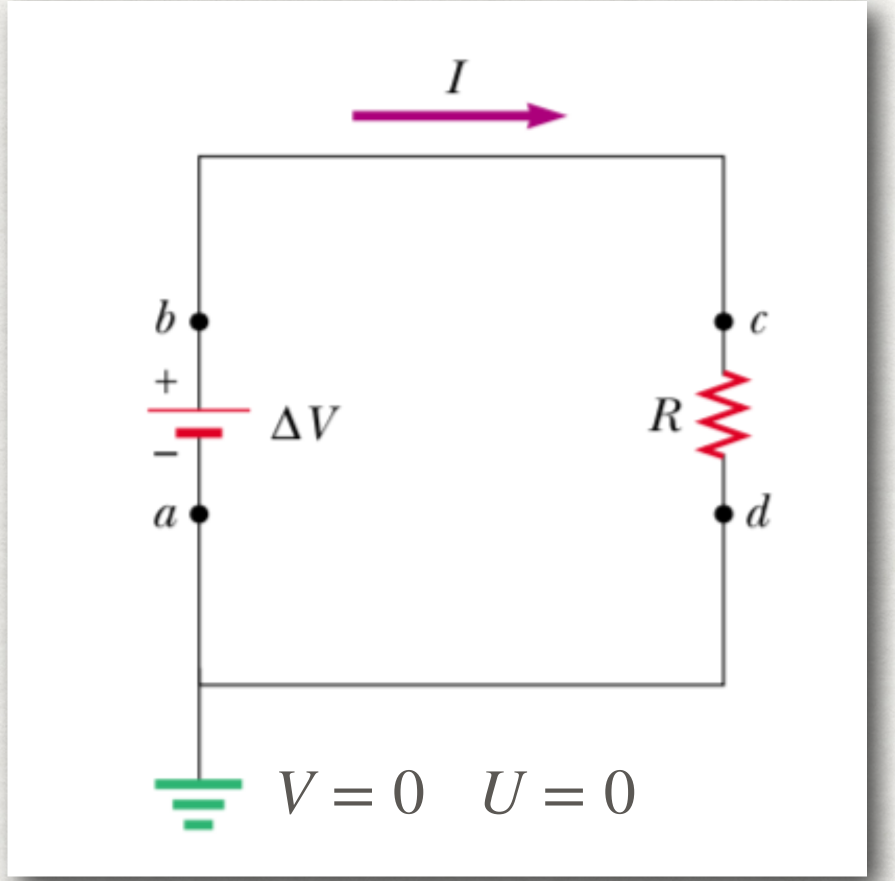
energía eléctrica y potencia:



$$\Delta V = I R$$

$$a \rightarrow b \qquad dU = \Delta V \, dQ$$

$$c \rightarrow d \qquad dU = - \Delta V \, dQ$$

$$\mathscr{P} = \frac{dU}{dt} = \Delta V \frac{dQ}{dt} = \Delta V I$$ *ritmo de cambio de la energía*

$$\mathscr{P} = I \Delta V = I^2 R = \frac{(\Delta V)^2}{R}$$ *potencia entregada al resistor*

$\sim 765 \, kV$

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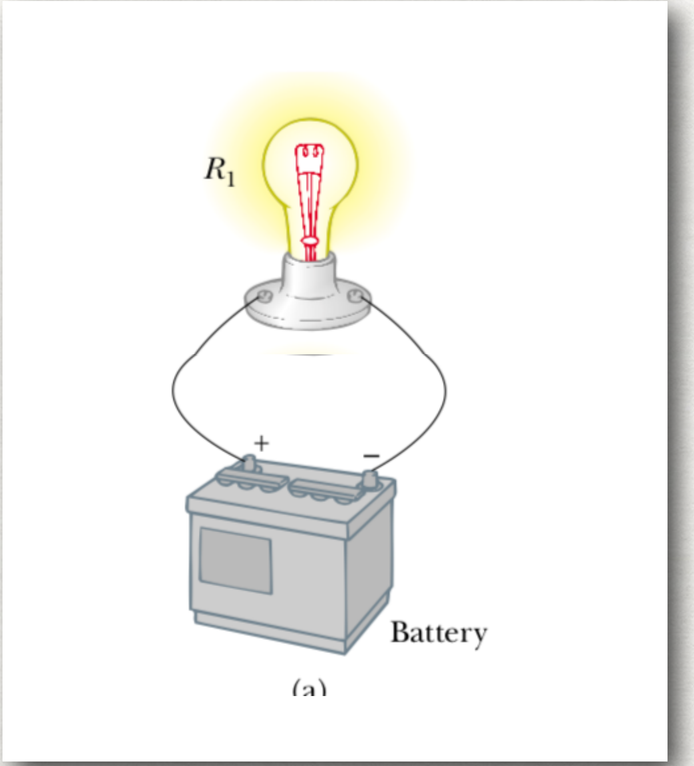
energía eléctrica y potencia:



$$\Delta V = 12\,V$$
$$R = 6\,\Omega$$
$$I = ?$$
$$\mathscr{P} = ?$$

$$\Delta V = I R$$
$$I = \frac{\Delta V}{R} = \frac{12\,V}{6\,\Omega} = 2\,A$$
$$\mathscr{P} = I\,\Delta V = 2\,A\;12\,V = 24\,W$$

$$\Delta V = 120\,V$$
$$\mathscr{P} = 24\,W$$
$$I = ?$$
$$R = ?$$

$$\mathscr{P} = I\,\Delta V$$
$$I = \frac{\mathscr{P}}{\Delta V} = \frac{24\,W}{120V} = 0.2\,A$$
$$R = \frac{\Delta V}{I} = \frac{120\,V}{0.2\,A} = 600\,\Omega$$

$$\Delta V = 12\,V$$
$$R = 600\,\Omega$$
$$I = ?$$
$$\mathscr{P} = ?$$

$$I = \frac{\Delta V}{R} = \frac{12\,V}{600\,\Omega} = 0.02\,A$$
$$\mathscr{P} = I\,\Delta V = 0.02\,A\;12\,V = 0.24\,W$$

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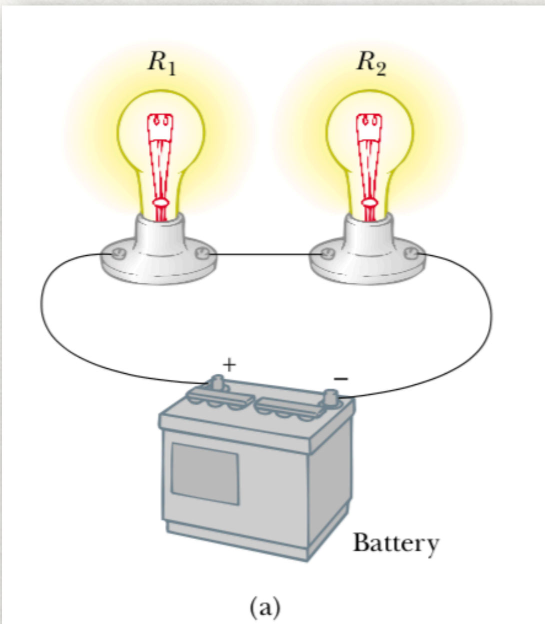
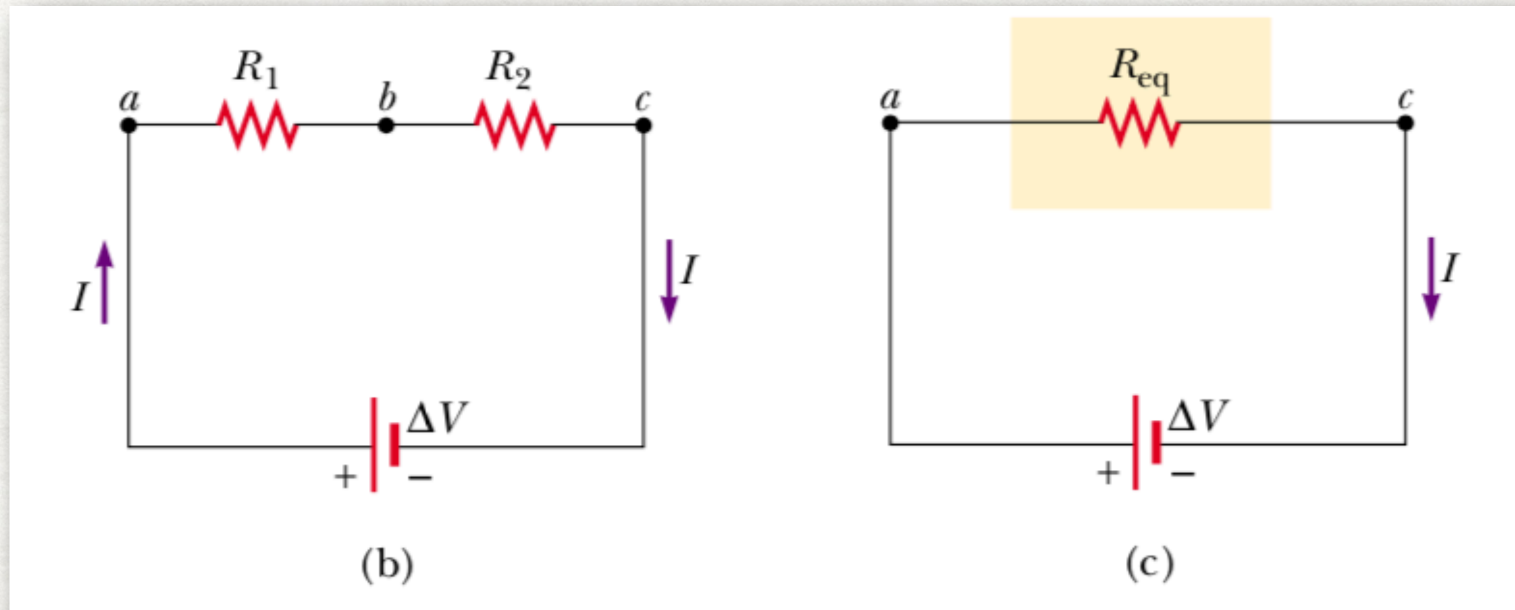
resistores en serie y paralelo:



(a)



(b) (c)

$$\Delta V = I R$$

$$\Delta V = I R_1 + I R_2 \; = I (R_1 + R_2) \; = I R_{eq}$$

$$R_{eq} = R_1 + R_2 \qquad\qquad R_{eq} = R_1 + R_2 + R_3 + \ldots$$

resistencias en serie

al revés que los capacitores!

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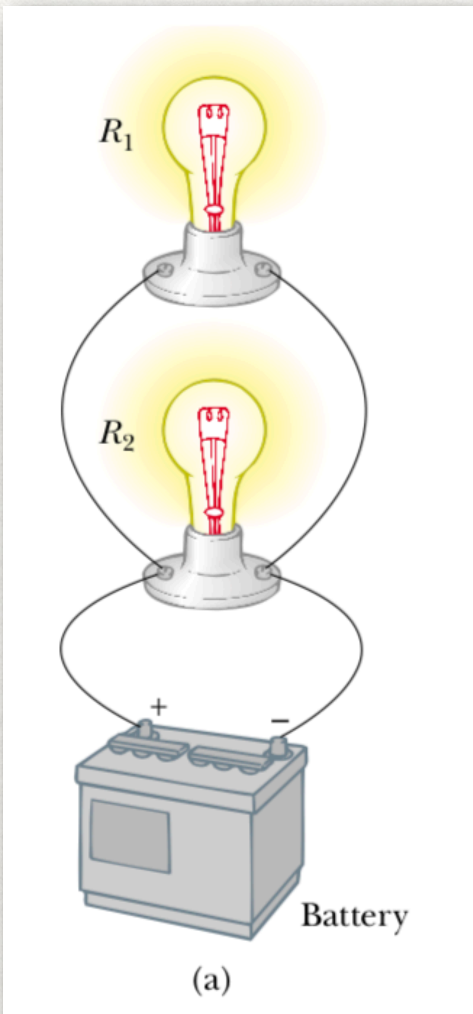
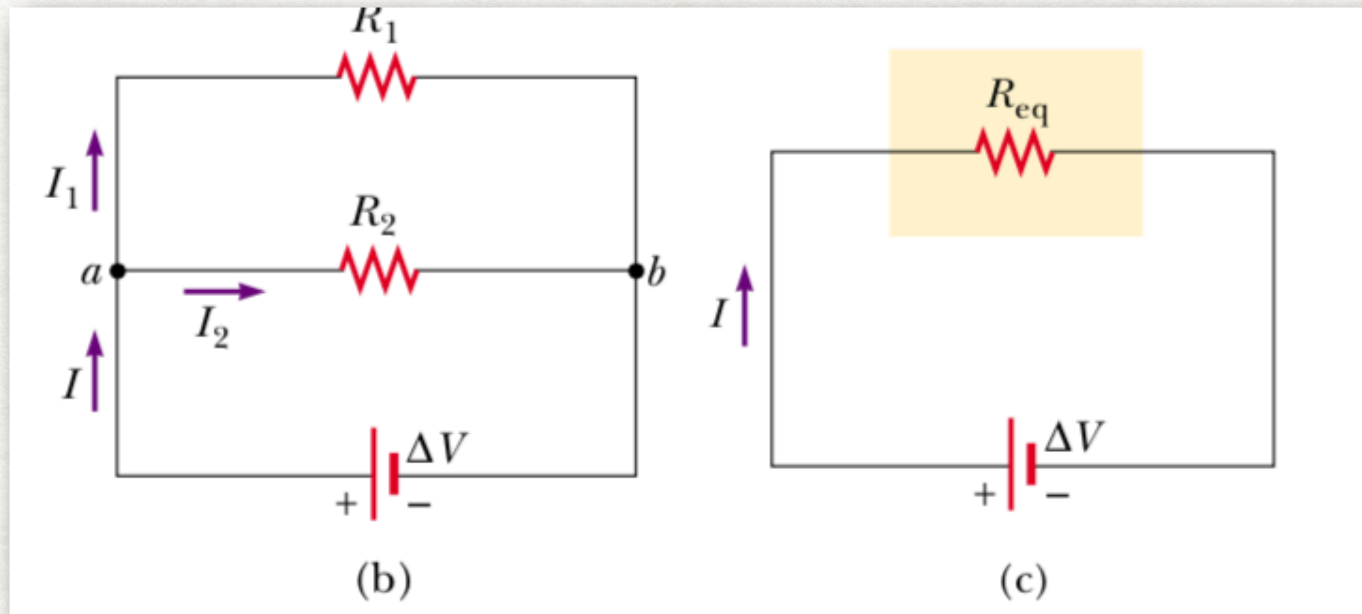
resistores en serie y paralelo:





$$\Delta V = I R$$

$$I = I_1 + I_2 = \frac{\Delta V}{R_1} + \frac{\Delta V}{R_2} = \Delta V \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = \frac{\Delta V}{R_{eq}}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

resistencias en paralelo