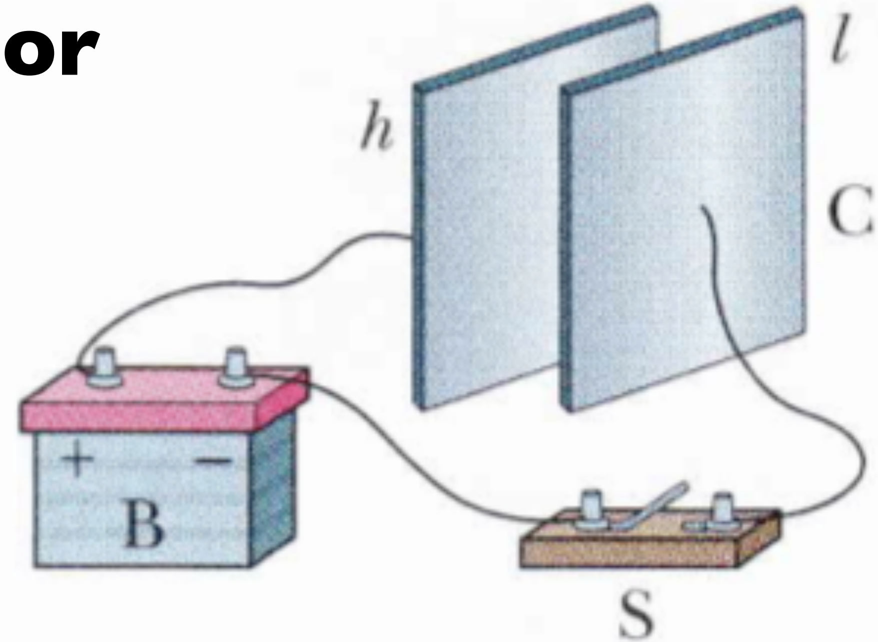
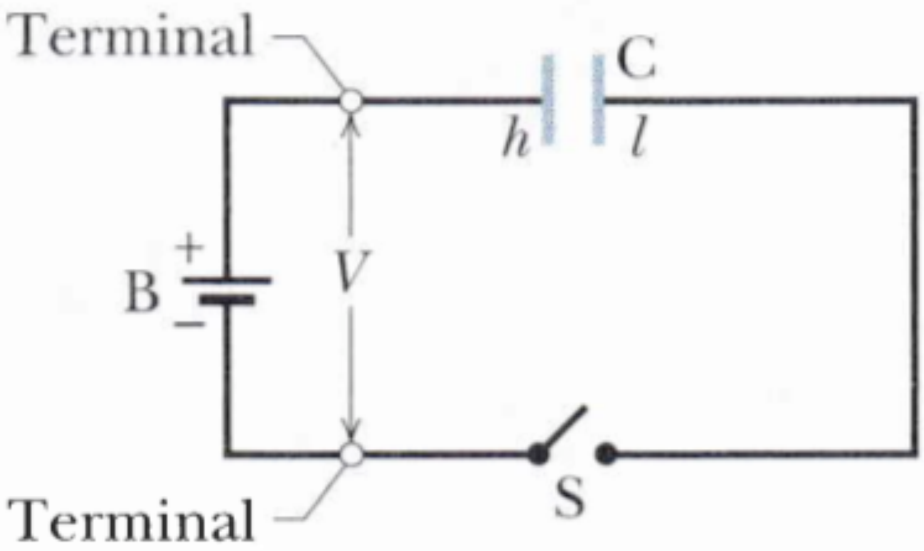
Clase 18

2/04/2014

Lecturas 26.1 - 26.7

Cargando un capacitor





Calculo de la capacitancia

1. Suponer que existe una carga q entre sus placas.
2. Calcular el campo eléctrico en términos de q.
3. Calcular V entre las placas
4. Calcular la capacitancia

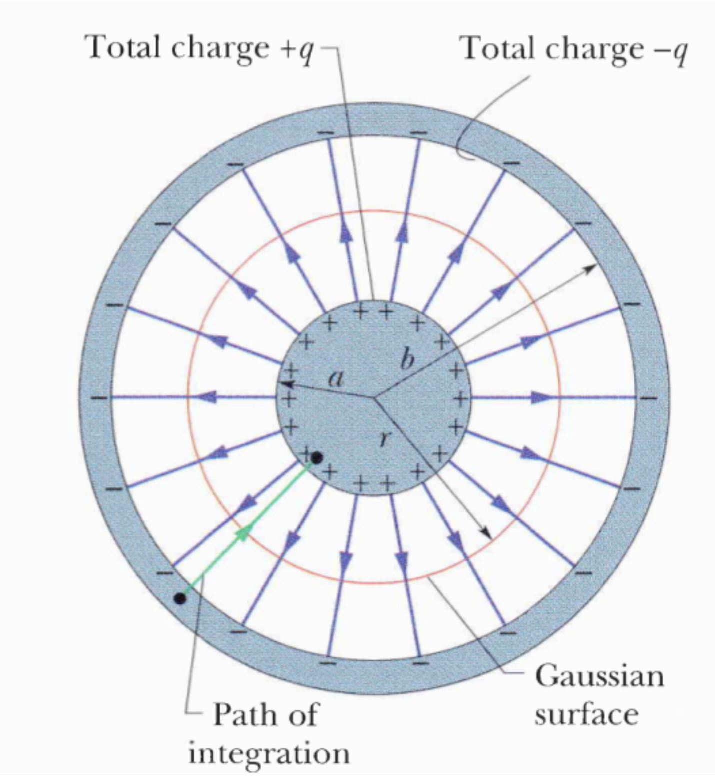
Capacitancia

Capacitor de placas paralelas

$$C = \frac{\varepsilon_0 A}{d}$$

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F/m} = 8.85\ \text{pF/m}.$$

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2.$$



Capacitor cilíndrico

$$C = 2\pi\varepsilon_0 \frac{L}{\ln(b/a)}$$

Capacitor esférico

$$C = 4\pi\varepsilon_0 \frac{ab}{b - a}$$

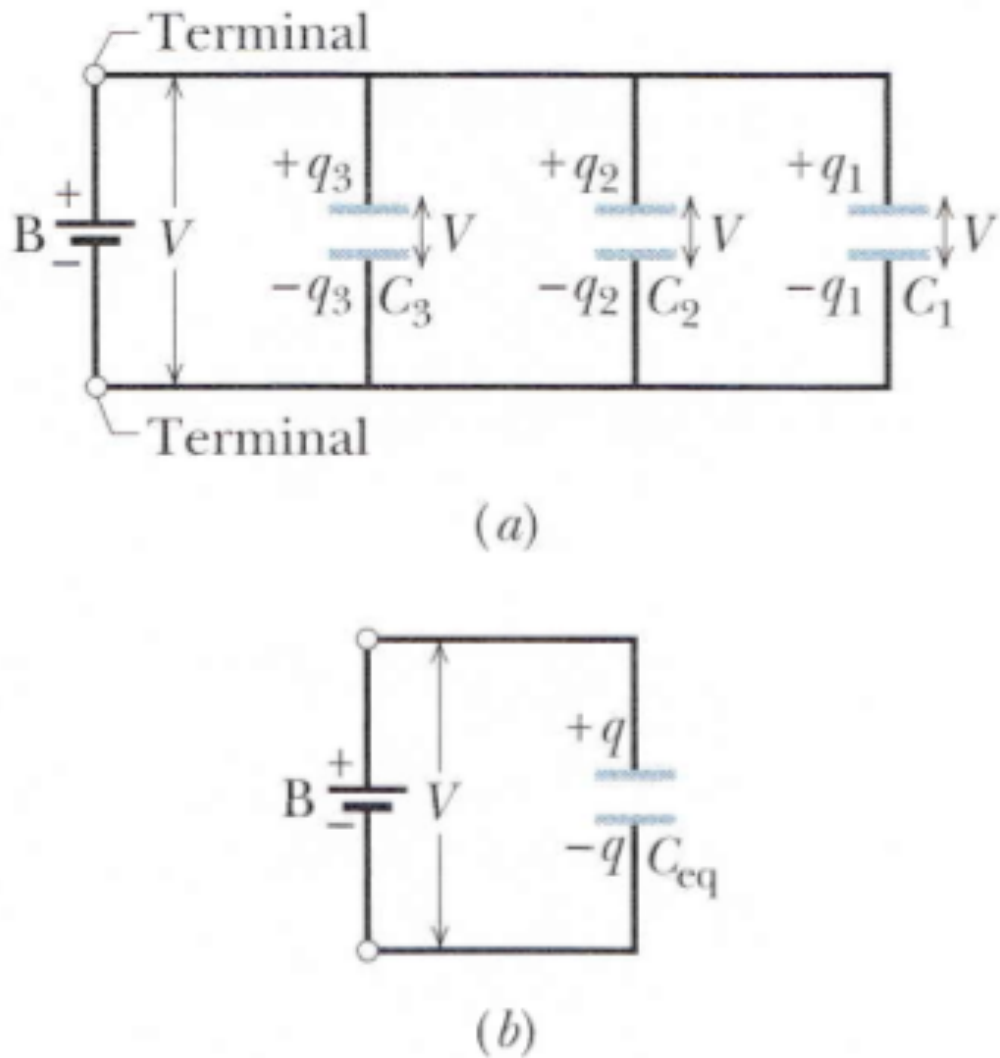
Una esfera aislada

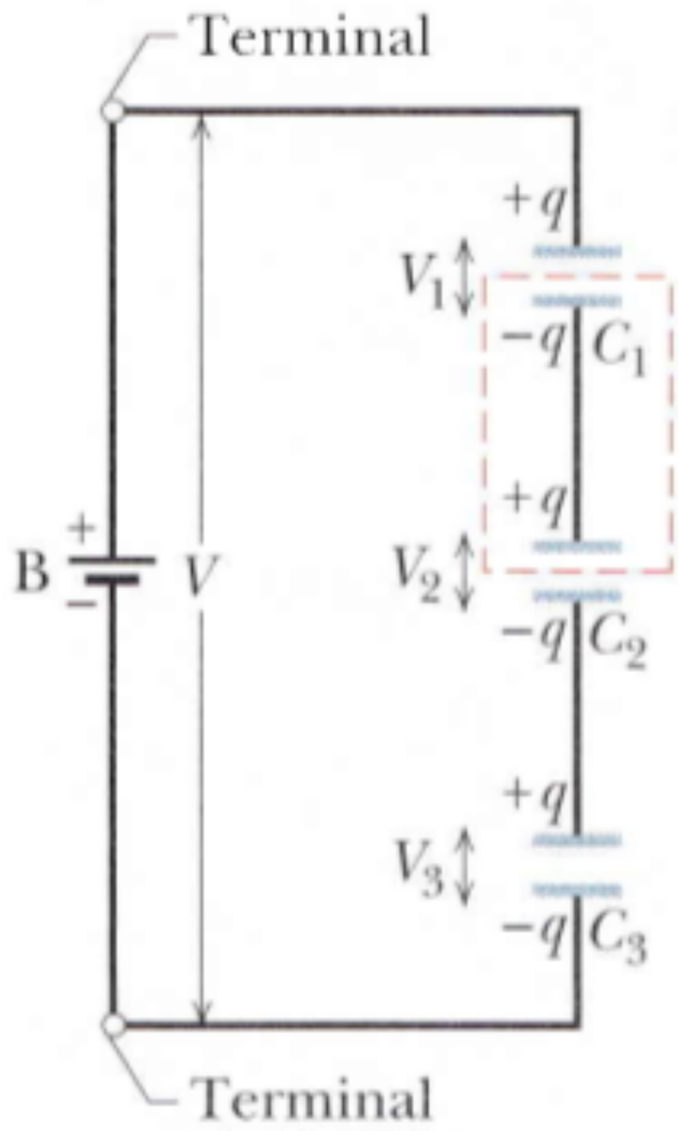
$$C = 4\pi\varepsilon_0 R$$

Condensadores en serie y en paralelo

Paralelo

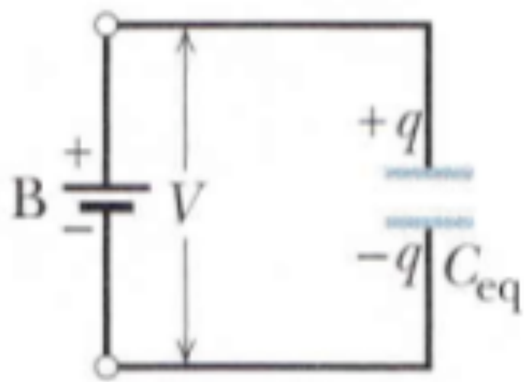
$$C_{eq} = \sum_{j=1}^{n} C_j$$

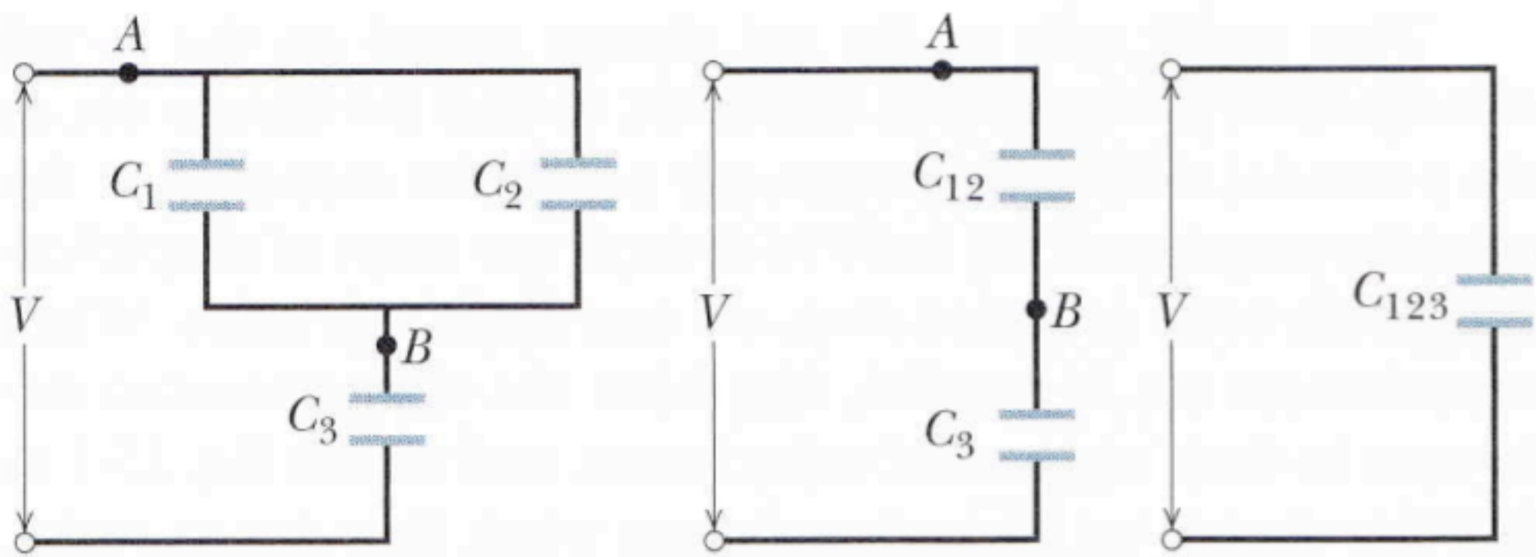




Serie

$$\frac{1}{C_{eq}} = \sum_{j=1}^{n} \frac{1}{C_j}$$





A
B
V
C_1
C_2
C_3
A
B
V
C_{12}
C_3
V
C_{123}

Energía almacenada en el campo eléctrico

En un instante dado se ha cargado un condensador con una carga q'

Trabajo extra para llevar una carga extra infinitesimal

$$dW = V'\,dq'$$

$$U = \frac{q^2}{2C}$$

$$U = \tfrac{1}{2}CV^2$$

Densidad de energía

$$u = \tfrac{1}{2}\varepsilon_0 E^2$$

Capacitor con dieléctrico

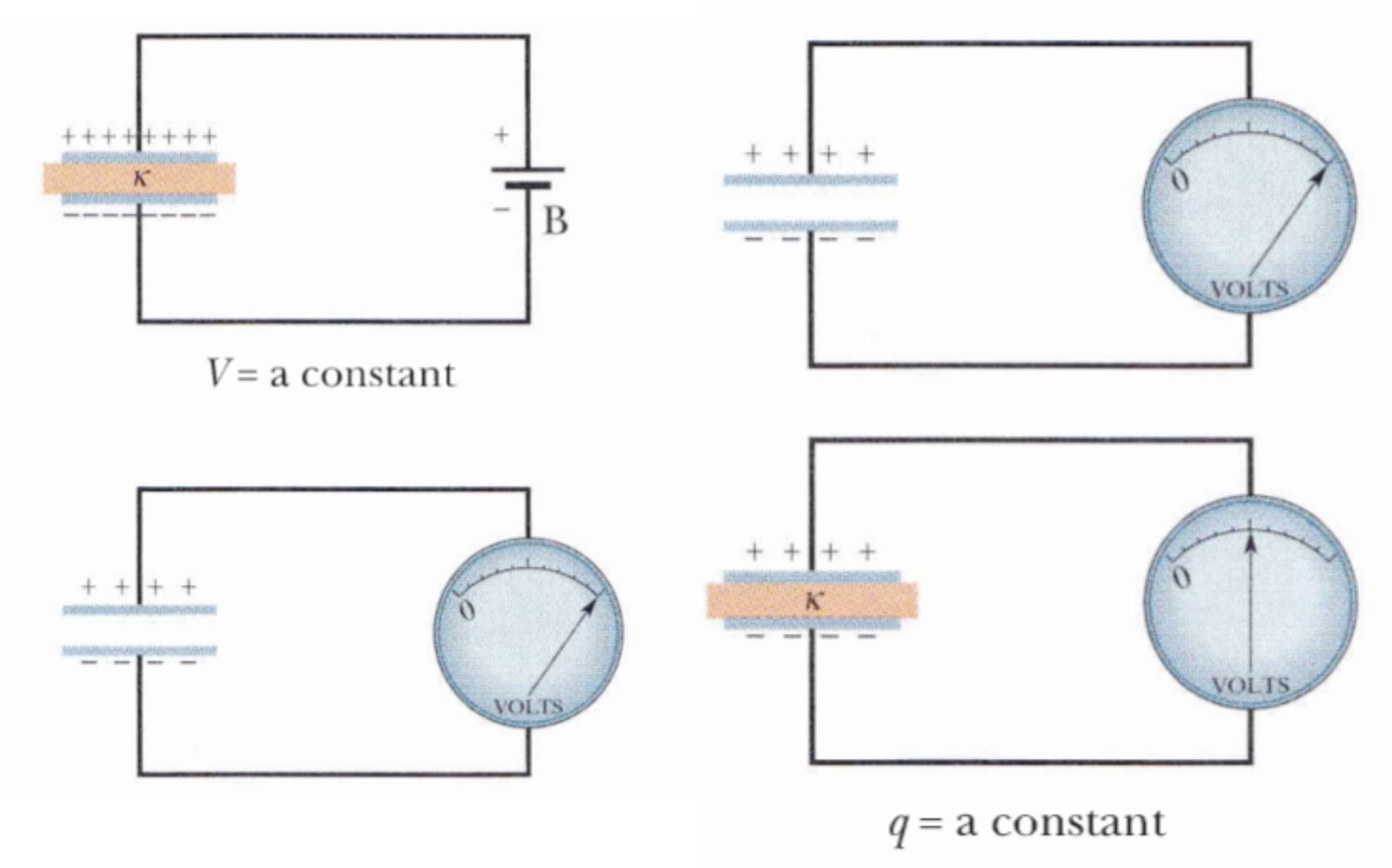
Capacitor con dieléctrico

$$C = \varepsilon_0 \mathscr{L},$$

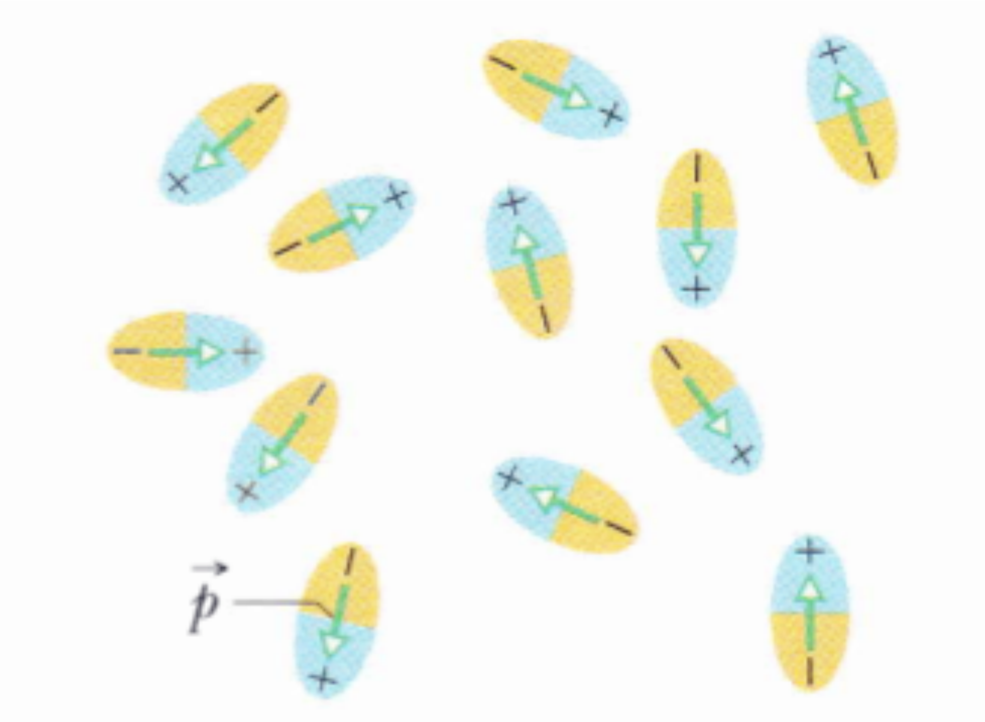
$$C = \kappa\varepsilon_0 \mathscr{L} = \kappa C_{\text{air}},$$

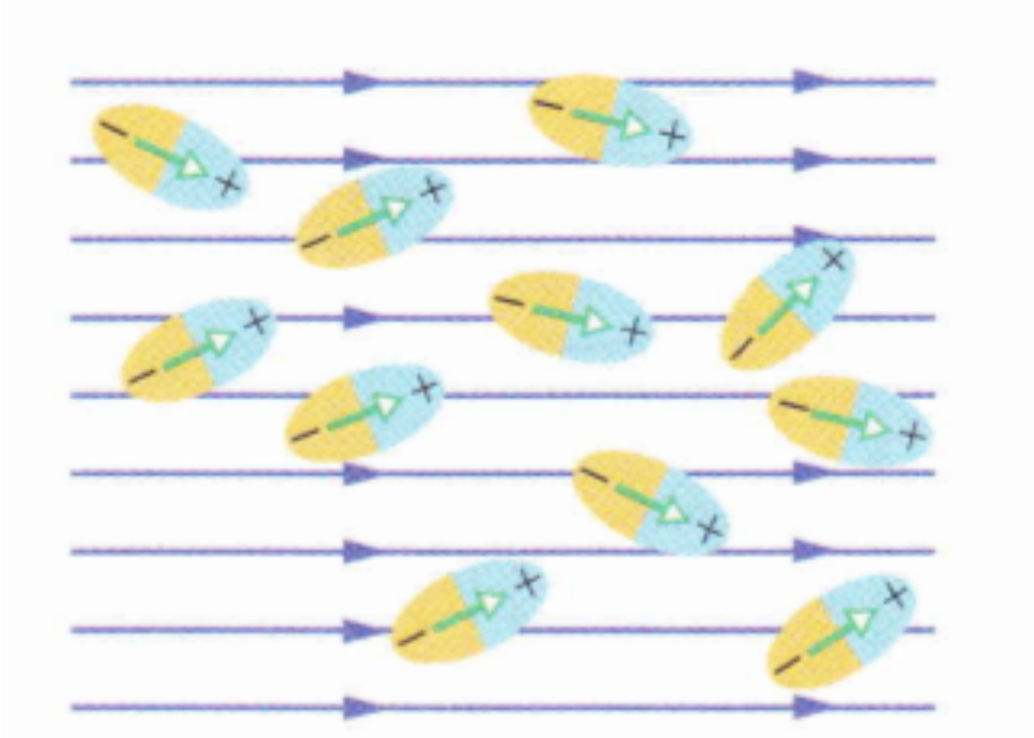
Material	Dielectric Constant κ	Dielectric Strength (kV/mm)
Air (1 atm)	1.00054	3
Polystyrene	2.6	24
Paper	3.5	16
Transformer oil	4.5	
Pyrex	4.7	14
Ruby mica	5.4	
Porcelain	6.5	
Silicon	12	
Germanium	16	
Ethanol	25	
Water (20°C)	80.4	
Water (25°C)	78.5	
Titania ceramic	130	
Strontium titanate	310	8

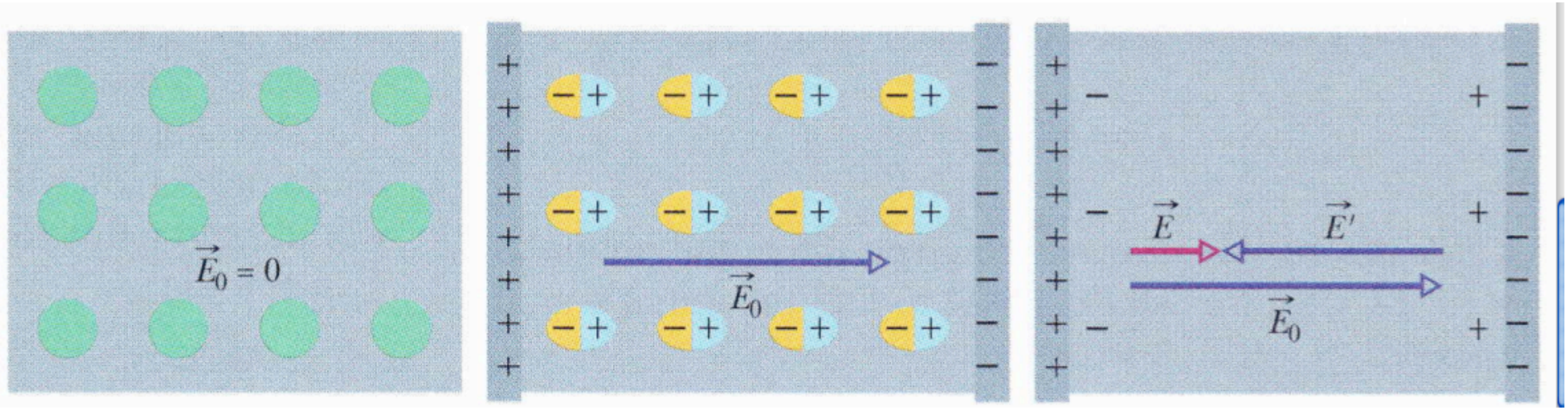
For a vacuum, κ = unity.



κ
B
V = a constant
0
VOLTS
0
VOLTS
κ
0
VOLTS
q = a constant


$\vec{p}$



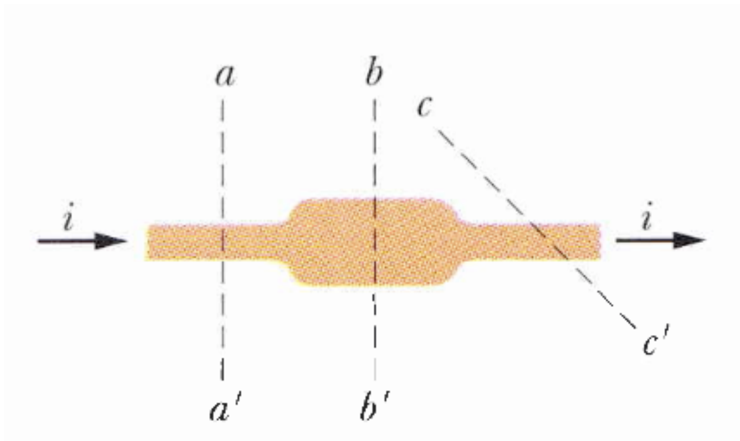

$\vec{E}_0 = 0$
$\vec{E}_0$
$\vec{E}$
$\vec{E}'$
$\vec{E}_0$

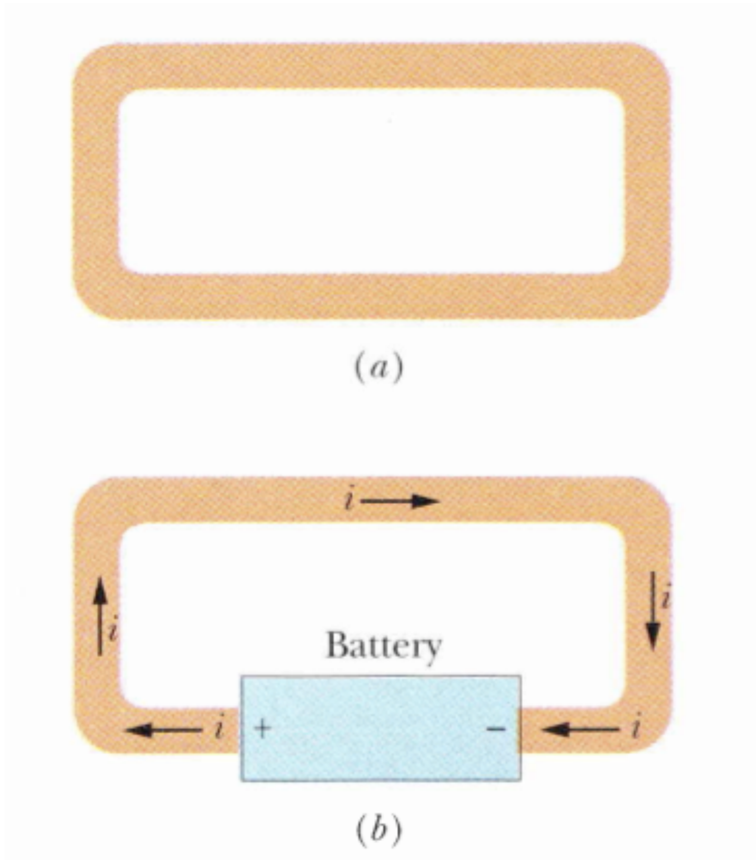
Corriente y Resistencia

Electrostática: Cargas en reposo

Electrodinámica: Cargas en movimiento

Corriente eléctrica

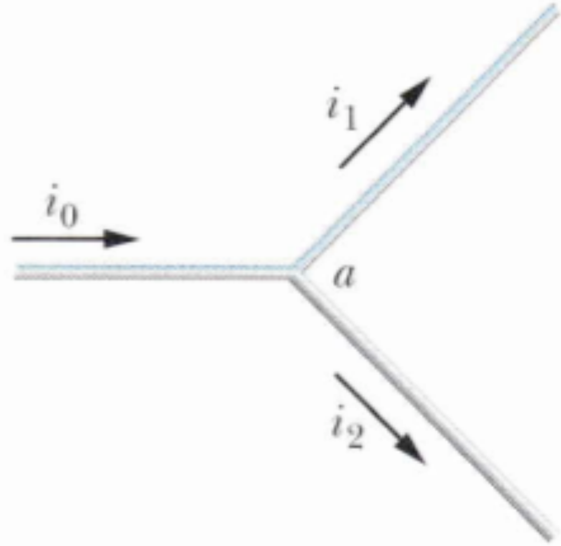




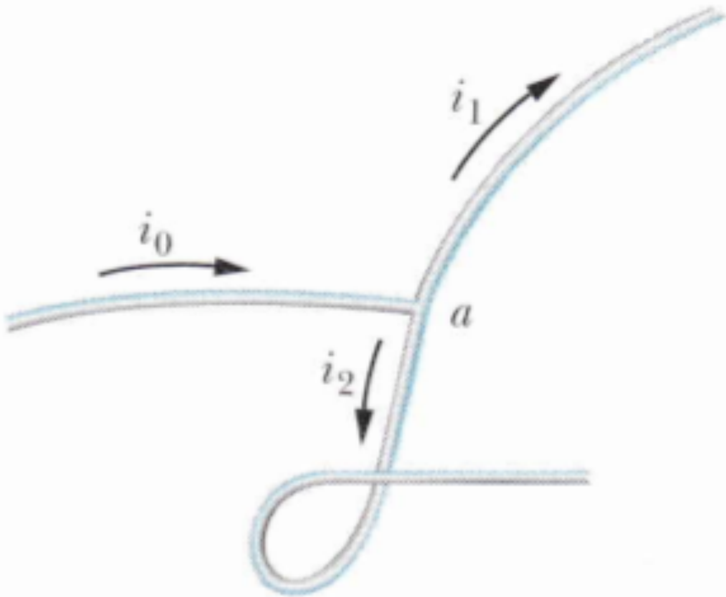
RECORRIDO DE LA CORRIENTE ELÉCTRICA.

Jaime Stanley 2010

$$i = \frac{dq}{dt}$$



(a)



(b)

1 ampere = 1 A = 1 coulomb per second = 1 C/s.

Densidad de corriente

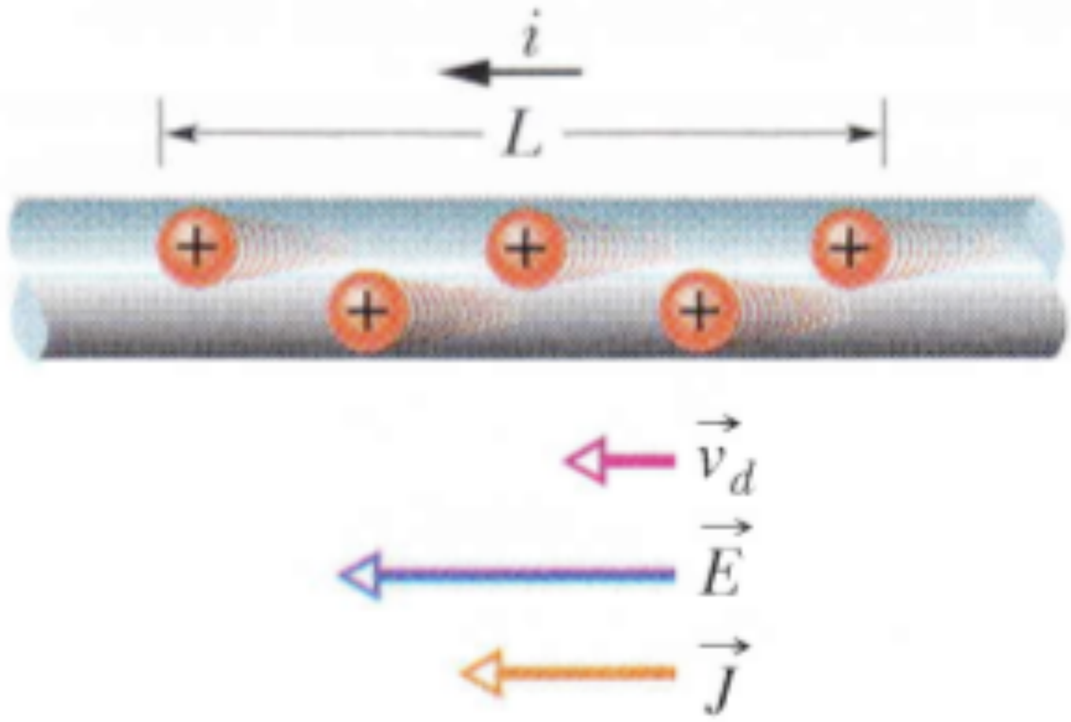
es medida de la corriente por unidad de área

$$i = \int \vec{J} \cdot d\vec{A}.$$

$$J = \frac{i}{A},$$

corriente uniforme y perpendicular al area

Velocidad de arrastre



Resistencia y resistividad

Resistor

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

$$1 \text{ ohm} = 1\ \Omega = 1 \text{ volt per ampere} = 1 \text{ V/A}.$$

 Símbolo

Resistividad del material

$$\rho = \frac{E}{J}$$

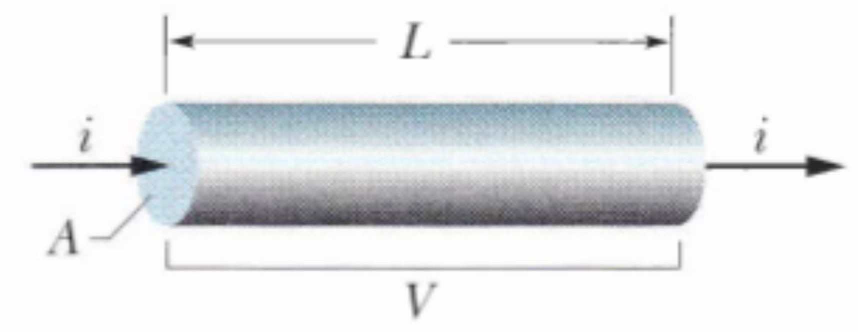
$$\frac{\text{unit } (E)}{\text{unit } (J)} = \frac{\text{V/m}}{\text{A/m}^2} = \frac{\text{V}}{\text{A}}\,\text{m} = \Omega \cdot \text{m}.$$

Conductividad

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

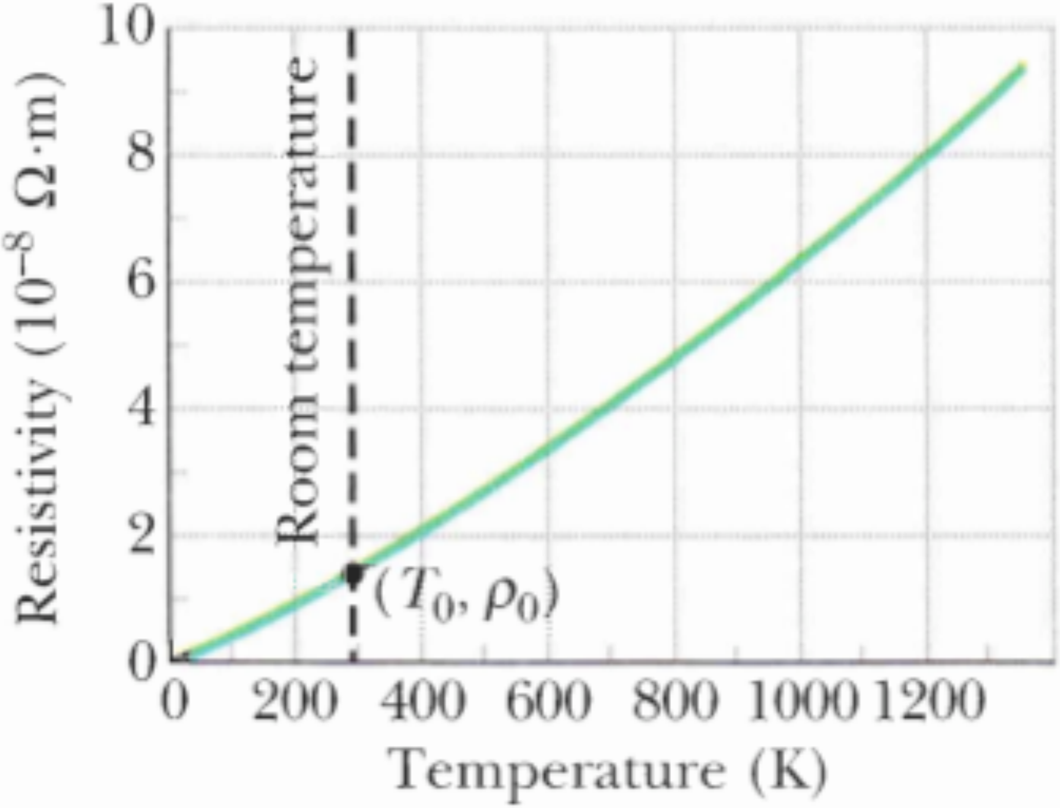
Material	Resistivity, ρ ($\Omega \cdot m$)	Temperature Coefficient of Resistivity, α (K^{-1})
	Typical Metals	
Silver	1.62×10^{-8}	4.1×10^{-3}
Copper	1.69×10^{-8}	4.3×10^{-3}
Gold	2.35×10^{-8}	4.0×10^{-3}
Aluminum	2.75×10^{-8}	4.4×10^{-3}
Manganin[a]	4.82×10^{-8}	0.002×10^{-3}
Tungsten	5.25×10^{-8}	4.5×10^{-3}
Iron	9.68×10^{-8}	6.5×10^{-3}
Platinum	10.6×10^{-8}	3.9×10^{-3}
	Typical Semiconductors	
Silicon, pure	2.5×10^{3}	-70×10^{-3}
Silicon, *n*-type[b]	8.7×10^{-4}	
Silicon, *p*-type[c]	2.8×10^{-3}	
	Typical Insulators	
Glass	$10^{10} - 10^{14}$	
Fused quartz	$\sim 10^{16}$	

La resistencia es una propiedad de un objeto
La resistividad es una propiedad de un material



$$\rho = \frac{E}{J} = \frac{V/L}{i/A}.$$

Variación con la temperatura

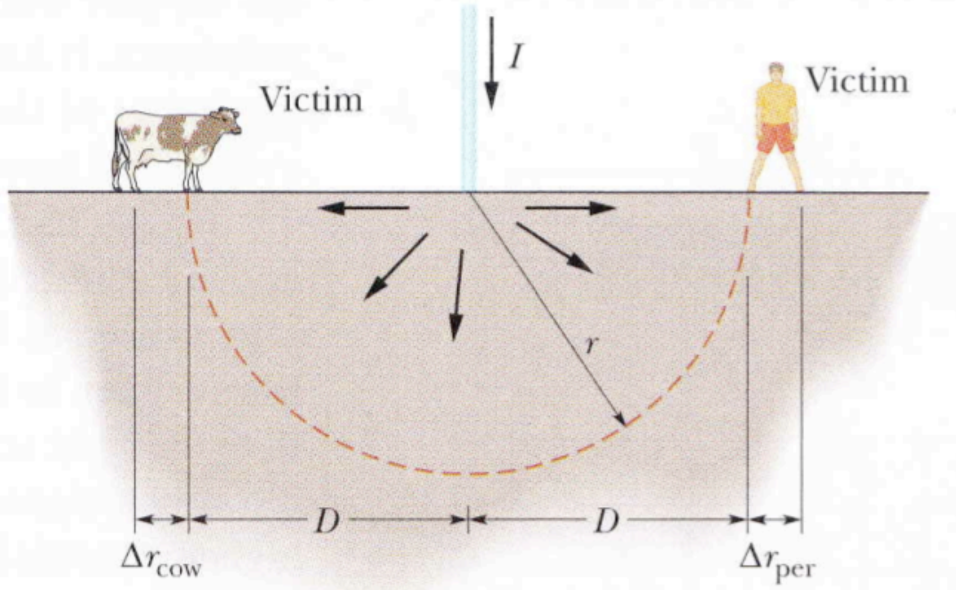


$$\rho - \rho_0 = \rho_0 \alpha (T - T_0).$$

$T_0 = 293$ K

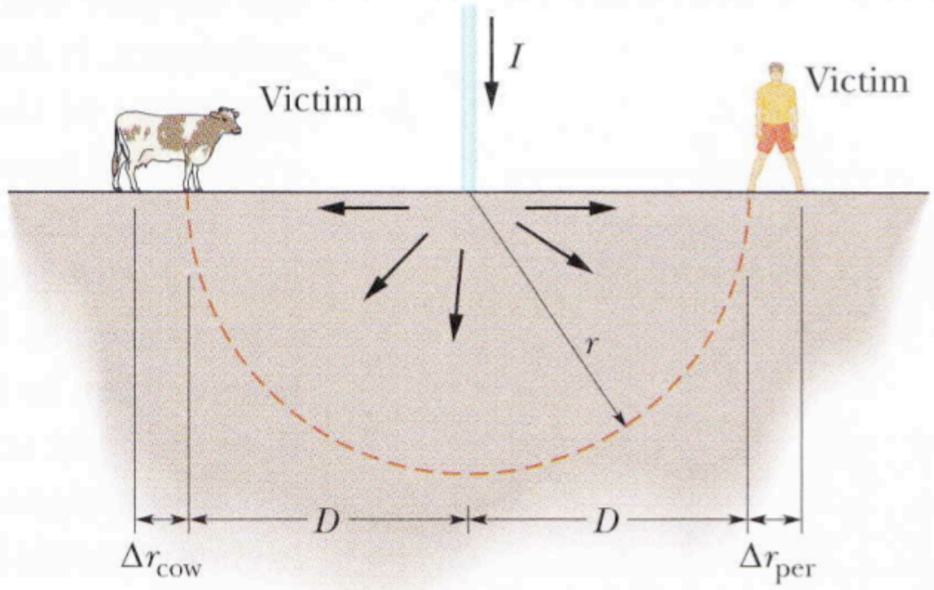
$\rho_0 = 1.69 \times 10^{-8}\ \Omega \cdot \mathrm{m}$

Figure 26-11 shows a person and a cow, each a radial distance $D = 60.0$ m from the point where lightning of current $I = 100$ kA strikes the ground. The current spreads through the ground uniformly over a hemisphere centered on the strike point. The person's feet are separated by radial distance $\Delta r_{per} = 0.50$ m; the cow's front and rear hooves are separated by radial distance $\Delta r_{cow} = 1.50$ m. The resistivity of the ground is $\rho_{gr} = 100\ \Omega \cdot$m. The resistance both across the person, between left and right feet, and across the cow, between front and rear hooves, is $R = 4.00$ kΩ.



(a) What is the current i_p through the person?

Figure 26-11 shows a person and a cow, each a radial distance $D = 60.0$ m from the point where lightning of current $I = 100$ kA strikes the ground. The current spreads through the ground uniformly over a hemisphere centered on the strike point. The person's feet are separated by radial distance $\Delta r_{per} = 0.50$ m; the cow's front and rear hooves are separated by radial distance $\Delta r_{cow} = 1.50$ m. The resistivity of the ground is $\rho_{gr} = 100\ \Omega \cdot \text{m}$. The resistance both across the person, between left and right feet, and across the cow, between front and rear hooves, is $R = 4.00\ \text{k}\Omega$.



(a) What is the current i_p through the person?

$$J = \frac{I}{2\pi r^2},$$

$$E = \rho_{gr} J = \frac{\rho_{gr} I}{2\pi r^2}.$$

$$\Delta V = -\int \vec{E} \cdot d\vec{s}$$

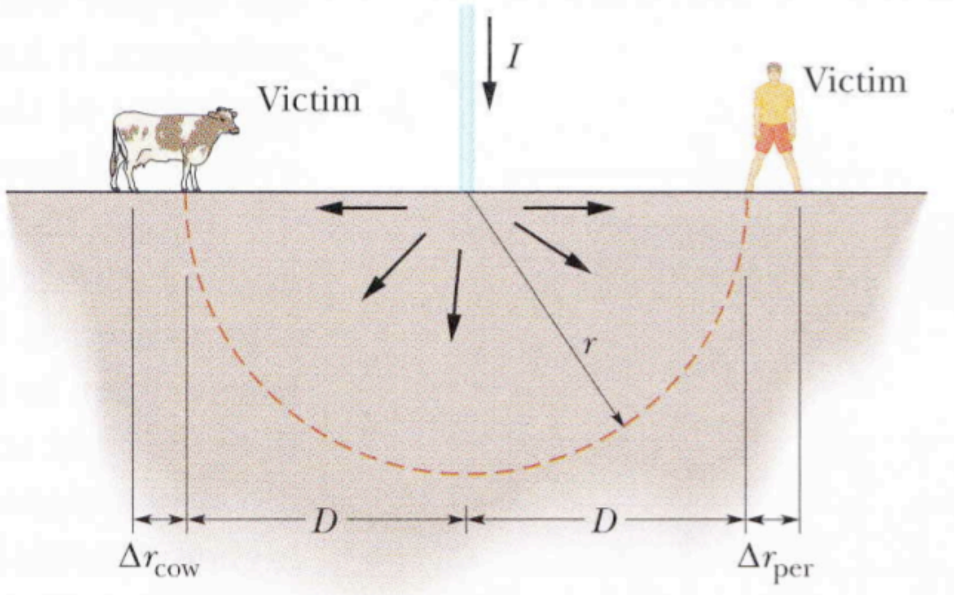
$$\Delta V = -\int_D^{D+\Delta r} E\, dr.$$

$$\Delta V = -\int_D^{D+\Delta r} \frac{\rho_{gr} I}{2\pi r^2}\, dr = -\frac{\rho_{gr} I}{2\pi}\left[-\frac{1}{r}\right]_D^{D+\Delta r}$$

$$= \frac{\rho_{gr} I}{2\pi}\left(\frac{1}{D+\Delta r} - \frac{1}{D}\right)$$

$$= -\frac{\rho_{gr} I}{2\pi}\frac{\Delta r}{D(D+\Delta r)}.$$

Figure 26-11 shows a person and a cow, each a radial distance $D = 60.0$ m from the point where lightning of current $I = 100$ kA strikes the ground. The current spreads through the ground uniformly over a hemisphere centered on the strike point. The person's feet are separated by radial distance $\Delta r_{per} = 0.50$ m; the cow's front and rear hooves are separated by radial distance $\Delta r_{cow} = 1.50$ m. The resistivity of the ground is $\rho_{gr} = 100\ \Omega \cdot \text{m}$. The resistance both across the person, between left and right feet, and across the cow, between front and rear hooves, is $R = 4.00\ \text{k}\Omega$.



(a) What is the current i_p through the person?

$$\Delta V = -\int_D^{D+\Delta r} \frac{\rho_{gr} I}{2\pi r^2}\, dr = -\frac{\rho_{gr} I}{2\pi}\left[-\frac{1}{r}\right]_D^{D+\Delta r}$$

$$= \frac{\rho_{gr} I}{2\pi}\left(\frac{1}{D+\Delta r} - \frac{1}{D}\right)$$

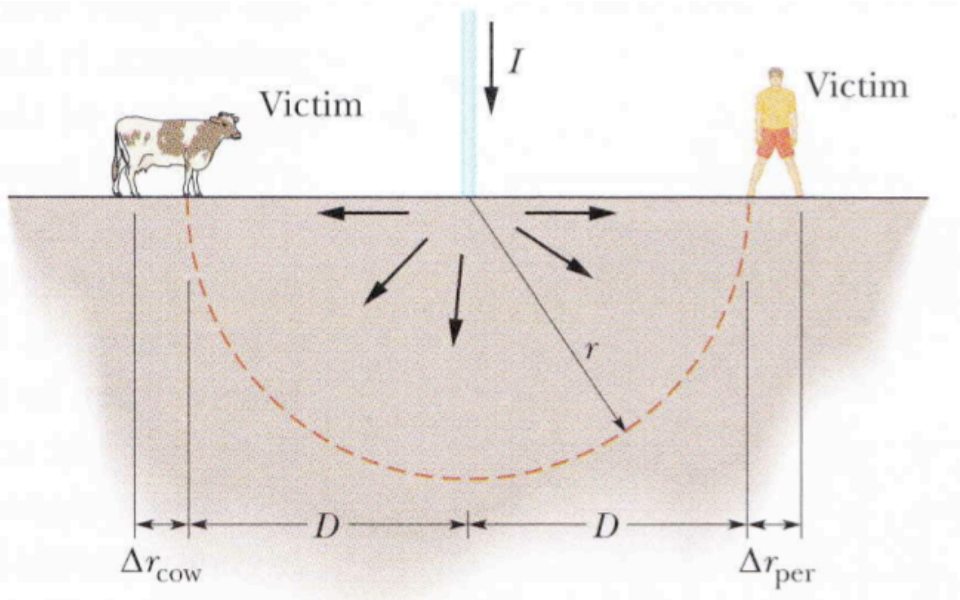
$$= -\frac{\rho_{gr} I}{2\pi}\frac{\Delta r}{D(D+\Delta r)}.$$

$$i = \frac{V}{R} = \frac{\rho_{gr} I}{2\pi}\frac{\Delta r}{D(D+\Delta r)}\frac{1}{R}.$$

$$i_p = \frac{(100\ \Omega\cdot\text{m})(100\ \text{kA})}{2\pi} \times \frac{0.50\ \text{m}}{(60\ \text{m})(60.0\ \text{m} + 0.50\ \text{m})}\frac{1}{4.00\ \text{k}\Omega}$$

$$= 0.0548\ \text{A} = 54.8\ \text{mA}.$$

Figure 26-11 shows a person and a cow, each a radial distance $D = 60.0$ m from the point where lightning of current $I = 100$ kA strikes the ground. The current spreads through the ground uniformly over a hemisphere centered on the strike point. The person's feet are separated by radial distance $\Delta r_{\text{per}} = 0.50$ m; the cow's front and rear hooves are separated by radial distance $\Delta r_{\text{cow}} = 1.50$ m. The resistivity of the ground is $\rho_{gr} = 100\ \Omega \cdot \text{m}$. The resistance both across the person, between left and right feet, and across the cow, between front and rear hooves, is $R = 4.00\ \text{k}\Omega$.

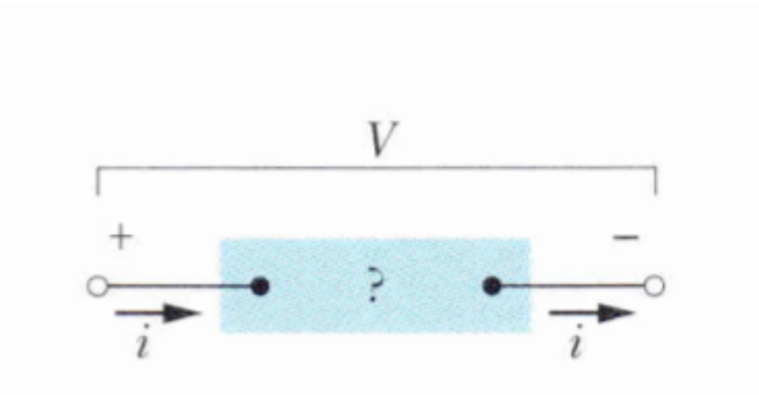


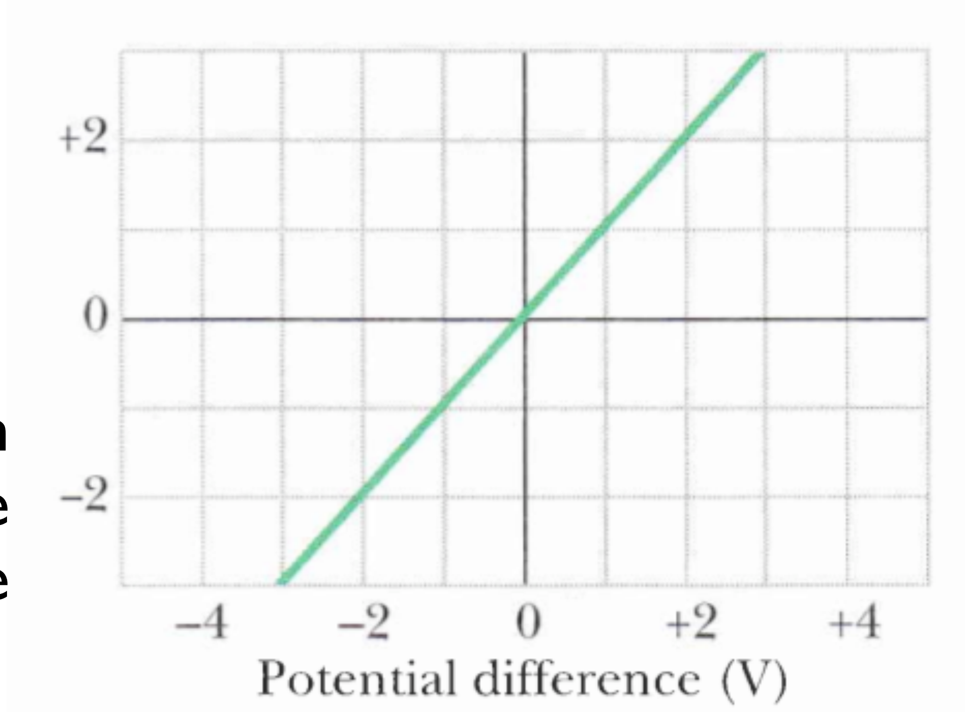
(a) What is the current i_p through the person?

$$i_p = \frac{(100\ \Omega \cdot \text{m})(100\ \text{kA})}{2\pi} \times \frac{0.50\ \text{m}}{(60\ \text{m})(60.0\ \text{m} + 0.50\ \text{m})} \frac{1}{4.00\ \text{k}\Omega}$$
$$= 0.0548\ \text{A} = 54.8\ \text{mA}.$$

$$i_c = 0.162\ \text{A} = 162\ \text{mA},$$

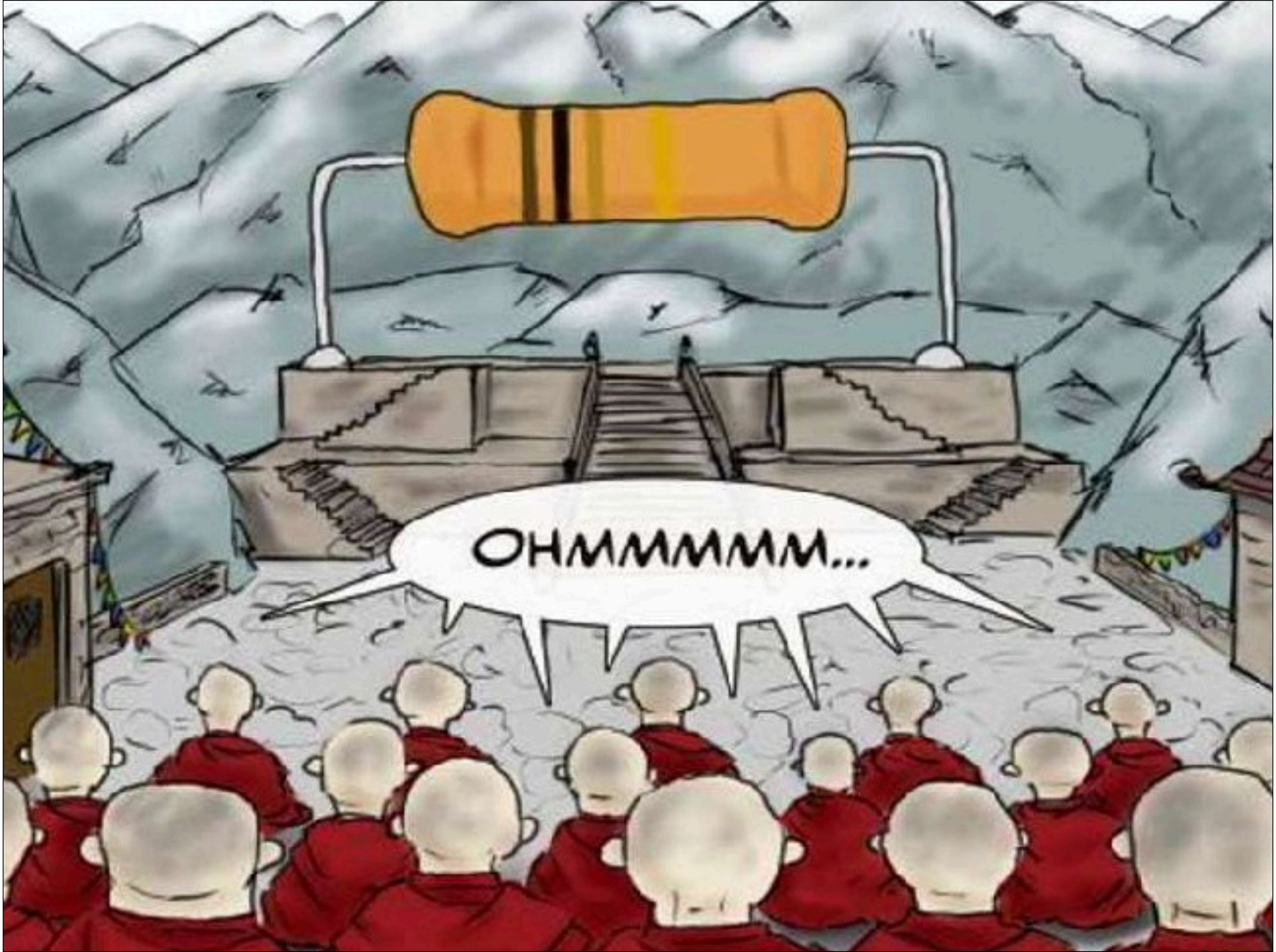
Ley de Ohm





La corriente que pasa por un dispositivo es siempre directamente proporcional a la diferencia de potencial aplicada

Un dispositivo conductor obedece la Ley de Ohm cuando la resistencia del dispositivo es independiente de la magnitud y de la polaridad de la diferencia de potencial aplicada


OHMMMMM...

Potencia

$$dU = dq\,V = i\,dt\,V.$$

$$P = iV$$

$$1\,\mathrm{V \cdot A} = \left(1\,\frac{\mathrm{J}}{\mathrm{C}}\right)\left(1\,\frac{\mathrm{C}}{\mathrm{s}}\right) = 1\,\frac{\mathrm{J}}{\mathrm{s}} = 1\,\mathrm{W}.$$