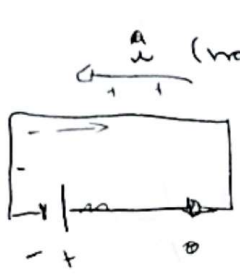
Cap 26: Corrente e Resistência

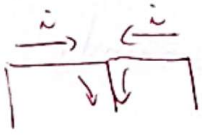


$i = \frac{dq}{dt}$ Direção de $\hat{i}$: movimento das cargas (+)

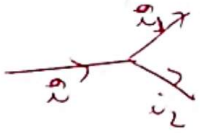
↓

intensidade de corrente

$i = \frac{dq}{dt} \Rightarrow q = \int_0^t i\,dt$



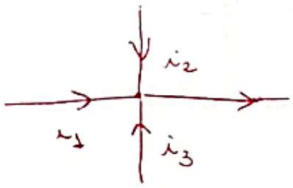
$[i] = \frac{C}{s} = A$ (Ampère)



$i = i_1 + i_2$

• Densidade de corrente:

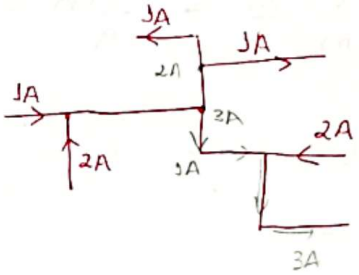
= ao fluxo de i ~~carga~~ em uma area.

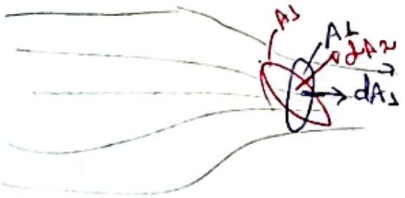


$J = \frac{dq}{dA\,dt}$

$\frac{dq}{dt} = J\,dA$

$i = \int \vec{J}\,d\vec{A}$

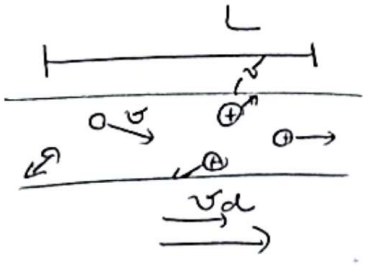




• Velocidade de deriva v_d (que dirige) (veja outra folha)

$i = \frac{q}{t} = nAe\,v_d$

$\Rightarrow v_d = \frac{i}{nAe} = \frac{J}{ne}$



$v_d \approx 10^{-5}\,m/s$

$v \approx 10^{6}\,m/s$

$v_d = \frac{L}{t}$

$\frac{v_d}{L} = \frac{1}{t}$



$q = neL.A$

↳ # cargas/m^3

$i = \frac{q}{t} = neA\cancel{L}\frac{v_d}{\cancel{L}}$

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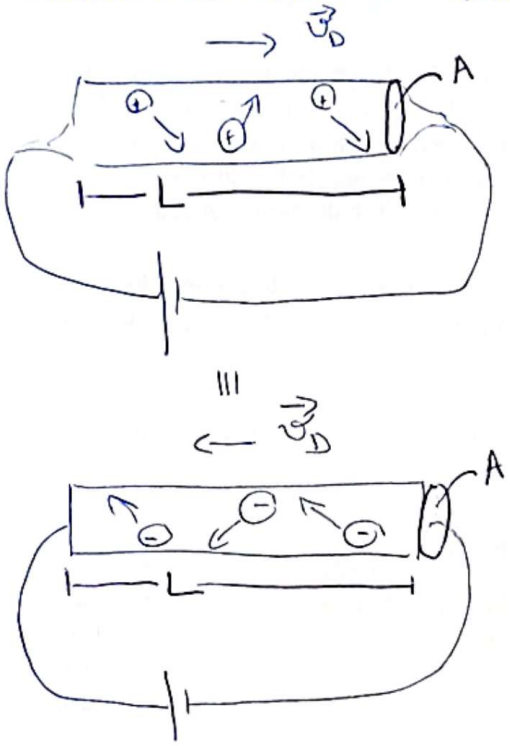
• Relacionando J com velocidade de deriva. (v_D)



Sabe-se: M → massa molar

ρ → densidade.

N_V → # elétrons de valência.

$$v_D = \frac{L}{\Delta t} \quad (1)$$

mas $$i = \frac{\Delta q}{\Delta t} = JA$$

$$\Rightarrow \frac{1}{\Delta t} = \frac{JA}{\Delta q} \quad (2)$$

(2) → (1): V

$$v_D = J\frac{AL}{\Delta q} \quad (3)$$

Δq quantidade de carga no volume.

$$\frac{\Delta q}{V} = N_V \cdot \frac{N}{V} \cdot e \quad (4) \qquad \Rightarrow \boxed{v_D = J}$$

e → carga de 1 elétron.

$$\frac{N}{V} = n = \frac{\#\text{átomos}}{\text{Volume}} = \underbrace{\frac{\#\text{átomos}}{\text{Mol}}}_{N_A} \cdot \underbrace{\frac{\text{Mol}}{\text{massa}}}_{\frac{1}{M}} \cdot \underbrace{\frac{\text{massa}}{\text{Volume}}}_{\rho}$$

N_A AVOGADRO

Logo:

$$\frac{N}{V} = N_A \frac{\rho}{M} \quad (5)$$

$$M = \frac{\text{massa}}{\text{Mol}}$$

(5) → (4):

$$\frac{\Delta q}{V} = N_V N_A \frac{\rho}{M} e \quad (6)$$

(6) → (3): $$v_D = \frac{JM}{N_V N_A \rho e} \Rightarrow J = v_D \frac{N_V N_A \rho e}{M}$$

densidade de carga.

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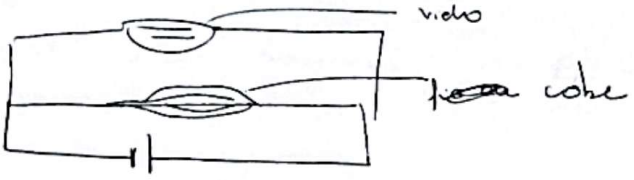
Resistencia e Resistividade



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

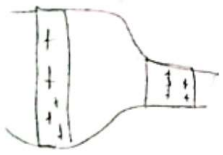
$$[R] = \frac{V}{A} = \text{ohm} = \Omega$$



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

$\downarrow$

a corrente é diminuida devido a presença do resistor



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

$\rightarrow$ resistor $\Rightarrow$ V_d diminui em todo circuito

$\Rightarrow$ i diminui em todo circuito

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

ρ = resistividade

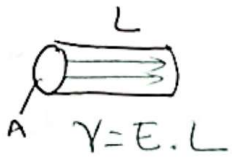
$$[\rho] = \frac{V}{m}\,\frac{m^2}{A} = \frac{V}{A}m = \Omega.m$$

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

$$\Rightarrow \vec{E} = \rho \vec{J} \quad ; \quad \vec{J} = \sigma \vec{E}$$

$$[\rho] = \Omega.m \qquad [R] = \Omega$$

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



$$R \propto \frac{L}{A} \qquad R = \rho \frac{L}{A}$$

$$\rho = R.\frac{A}{L} = \frac{V}{i}\,\frac{A}{L}$$

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

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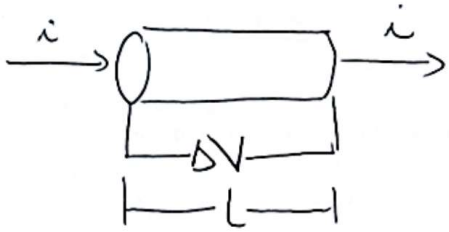
Calculo da resistência a partir da resistividade:



$$\Delta V = -\int_{1}^{2} \vec{E}\, d\vec{s} \quad \Rightarrow \quad \Delta V = E \cdot L$$

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

$$R = \frac{\Delta V}{i} \quad \Rightarrow \quad R = \frac{E \cdot L}{J \cdot A} \quad \Rightarrow \quad \boxed{R = \rho \frac{L}{A}}$$

ρ

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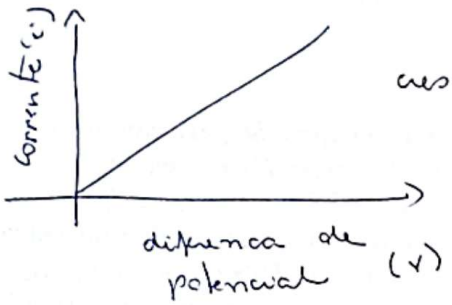
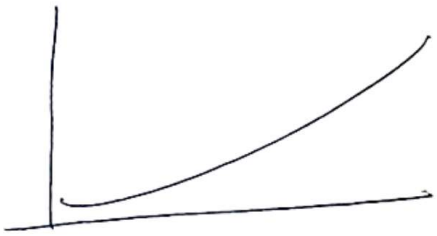
"Lei" de Ohm

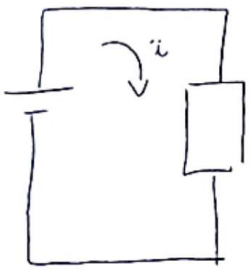


caso linearmente ; $\frac{i}{V} = cte$

mas isso nem sempre é verdade.



Potencia em circuitos elétricos:



$\Delta U = q_0 \Delta V$

$\Delta U = q \Delta V$

$Potencia = \frac{\Delta U}{\Delta t}$

$P = \frac{q \Delta V}{\Delta t}$

$P = i \Delta V$

$\boxed{P = iV}$

sabemos que $R = \frac{V}{i} \Rightarrow \begin{cases} V = Ri \\ i = \frac{V}{R} \end{cases}$

- $P = i^2 R$
- $P = \frac{V^2}{R}$

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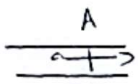
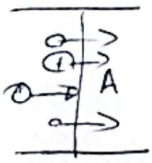
Cap. 26. Revisando:

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





corrente depende da espessura do fio.

$\Rightarrow$ • $J = \frac{dq}{dt\,dA}$ $\rightarrow$ $i = \int \vec{J} \cdot d\vec{A}$

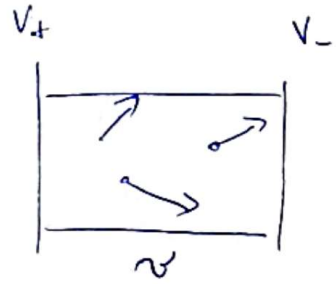
↳ densidade de corrente

- $v_D = \frac{J}{ne}$

$n = x \frac{\#\text{átomos}}{\text{Volume}} = \frac{\text{átomos}}{\text{mol}} \frac{\text{mol}}{\text{massa}} \frac{\text{massa}}{\text{Volume}}$

x ↓ # de elétrons de condução

$\frac{\text{átomos}}{\text{mol}}$ ↓ N_A ↓ ~~Avogado~~ AVOGADRO ($6{,}02 \cdot 10^{23}$)



$v \sim 10^6\, m/s$

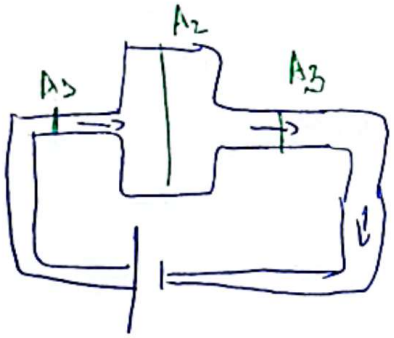
$v_d \sim 10^{-5}\, m/s$

- $R = \frac{\Delta V}{i}$ (dispositivo) $R = cte$! (pelo menos aqui no curso)

- $\rho = \frac{E}{J}$ (material) (resistividade) $\sigma = \frac{1}{\rho}$ condutividade

observe que se $\rho = 0 \Rightarrow E = 0$!

$\updownarrow R = \rho \frac{L}{A \uparrow}$



$i = cte$! efeito transito!

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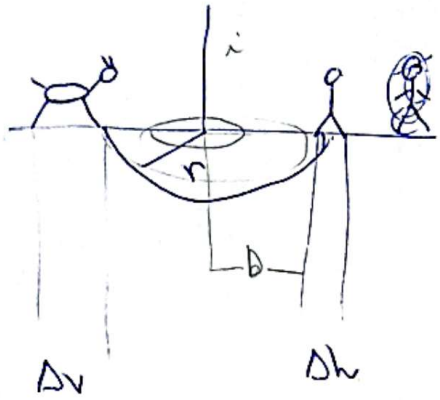
exemplo Homem - vaca



$$J = \frac{i}{A} = \frac{i}{2\pi r^2}$$

$$R_H = R_V = 4\,k\Omega$$

a) $i_h = ?$ $\quad R = \frac{\Delta V}{i} \Rightarrow i = \frac{\Delta V}{R_H} = ?$ (1)

b) $i_V = ?$

$$\Delta V = -\int \vec{E} \cdot d\vec{s} \qquad E = \rho_V \delta \qquad J = \frac{i_{solo}}{A} = \frac{i}{2\pi r^2} \quad (2)$$

$$\Delta V = -\int \rho_{solo} \frac{i}{2\pi r^2} dr$$

$$= -\frac{\rho_{solo}\, i}{2\pi}\left[-\frac{1}{r}\Big|_{D}^{D+\Delta h}\right] \quad \cdots \Rightarrow \quad \Delta V = \frac{\rho_{solo}\, i}{2\pi}\left(\frac{1}{D+\Delta h} - \frac{1}{D}\right) \quad (3)$$

$$\Delta V = \frac{\rho_{solo}\, i}{2\pi} \frac{\Delta h}{D(D+\Delta h)}$$

(3) em (1) $\Rightarrow$ temos i_H

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