Eletromagnetismo

$$\vec{\nabla} \cdot \vec{D} = \rho$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

$$\vec{\nabla} \cdot \vec{B} = 0$$

$$\vec{\nabla} \times \vec{H} = \vec{j} + \epsilon_0 \frac{\partial \vec{D}}{\partial t}$$

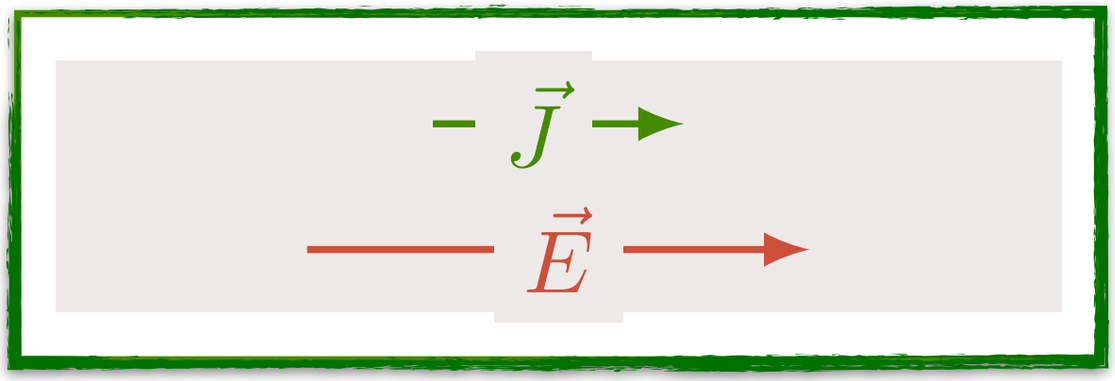
14 de julho de 2021

Eletrodinâmica

Eletrodinâmica
Corrente elétrica

- Condutividade elétrica

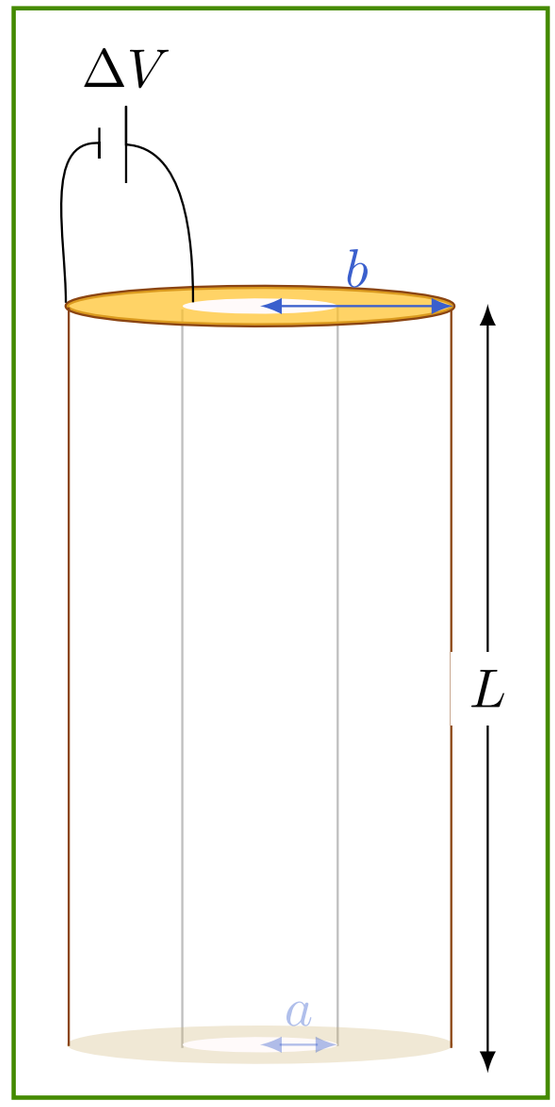
$$\vec{J} = \sigma \vec{E}$$



Pratique o que aprendeu

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

$I = ?$



Pratique o que aprendeu

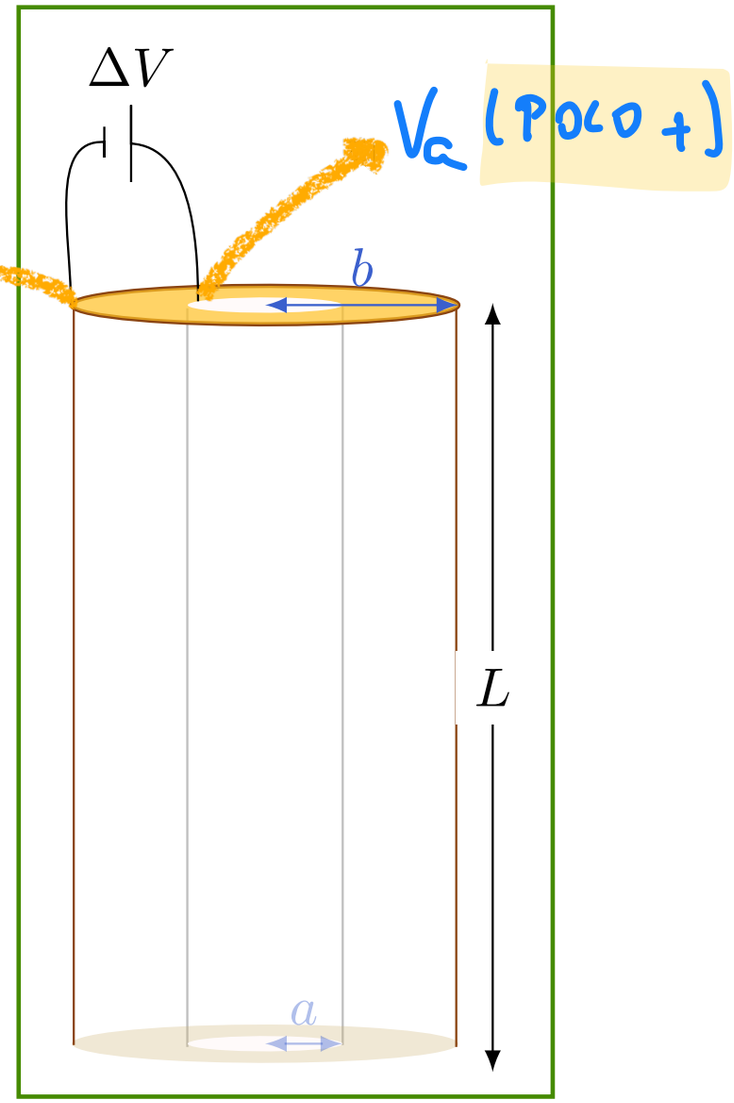
$$\vec{J} = \sigma \vec{E}$$

Q/L

LEI DE GAUSS

$$\vec{E} = \frac{1}{2\pi\epsilon} \frac{\lambda \hat{s}}{s}$$

$$V_a - V_b = \Delta V = \int_a^b \vec{E} \cdot \mathrm{d}\vec{\ell} > 0$$



Pratique o que aprendeu

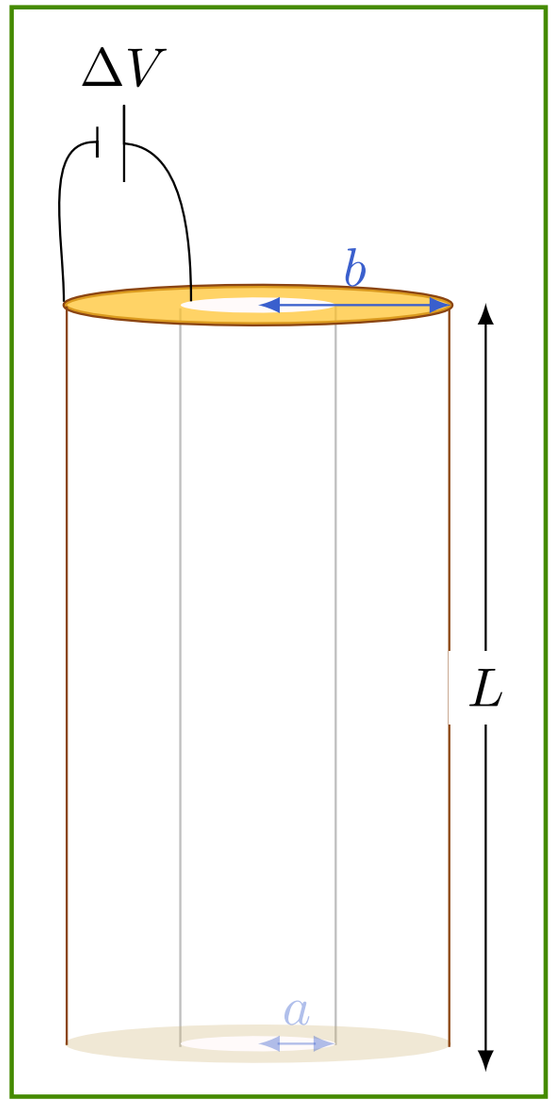
$$\vec{J} = \sigma \vec{E}$$

$$\vec{E} = \frac{1}{2\pi\epsilon} \frac{\lambda \hat{s}}{s}$$

$$\Delta V = \int_a^b \vec{E} \cdot \mathrm{d}\vec{\ell}$$

$\vec{E} \parallel \mathrm{d}\vec{\ell}$

$$\Delta V = \frac{\lambda}{2\pi\epsilon} \int_a^b \frac{\mathrm{d}s}{s}$$



Pratique o que aprendeu

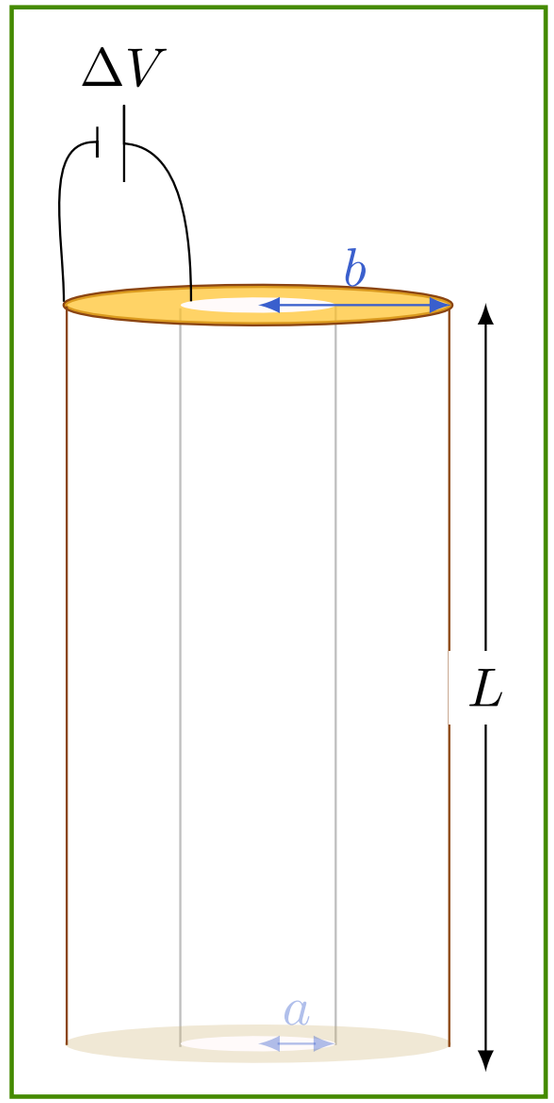
$$\vec{J} = \sigma \vec{E}$$

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\Delta V = \int_a^b \vec{E} \cdot \mathrm{d}\vec{\ell}$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon}\int_a^b \frac{\mathrm{d}s}{s}$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{b}{a}\right)$$

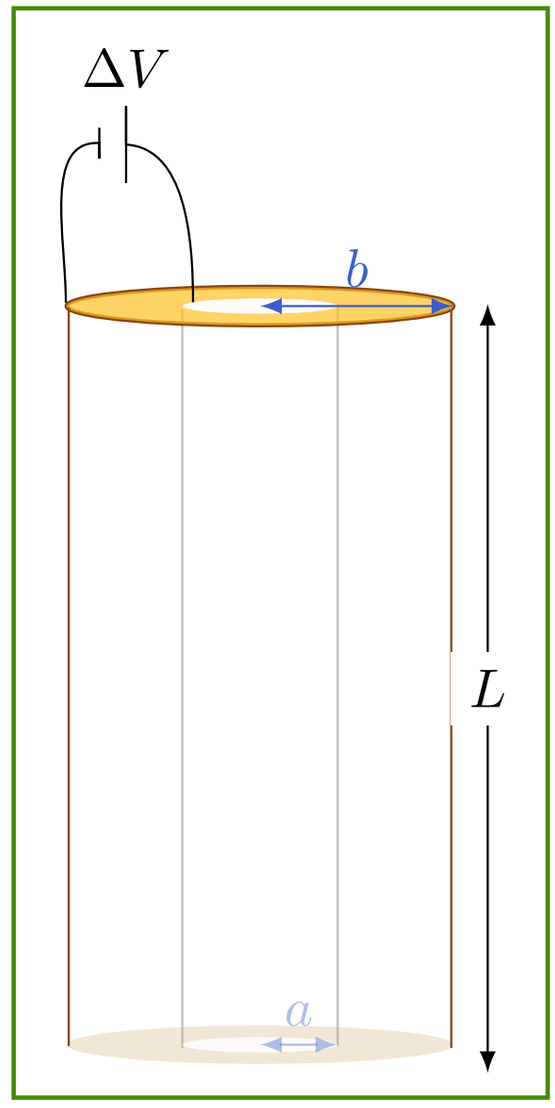


Pratique o que aprendeu

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

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{b}{a}\right)$$



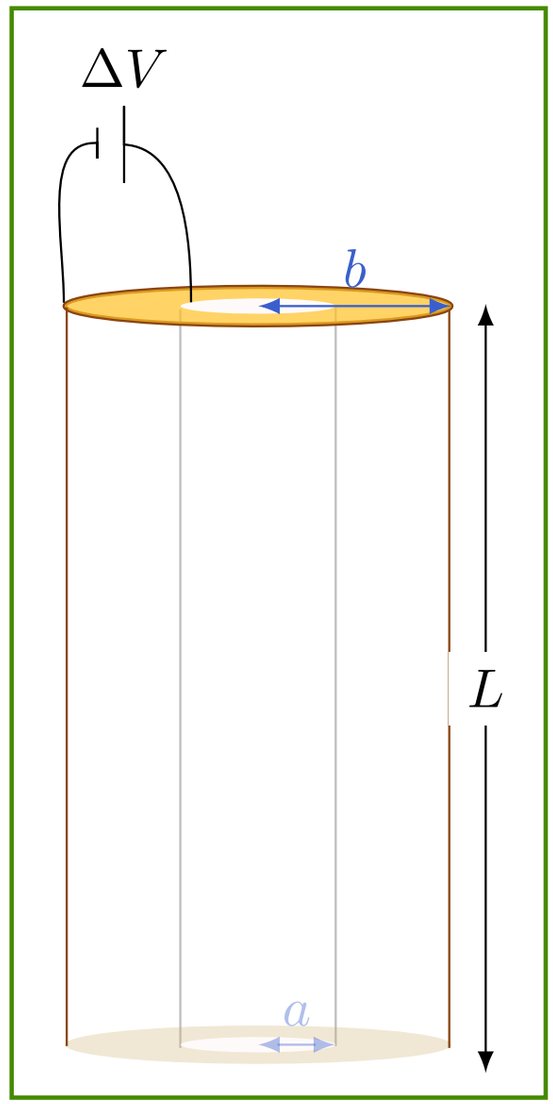
Pratique o que aprendeu

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

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{b}{a}\right)$$

$$\Delta V = \frac{Q}{2\pi\epsilon L}\log\left(\frac{b}{a}\right)$$



Pratique o que aprendeu

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

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

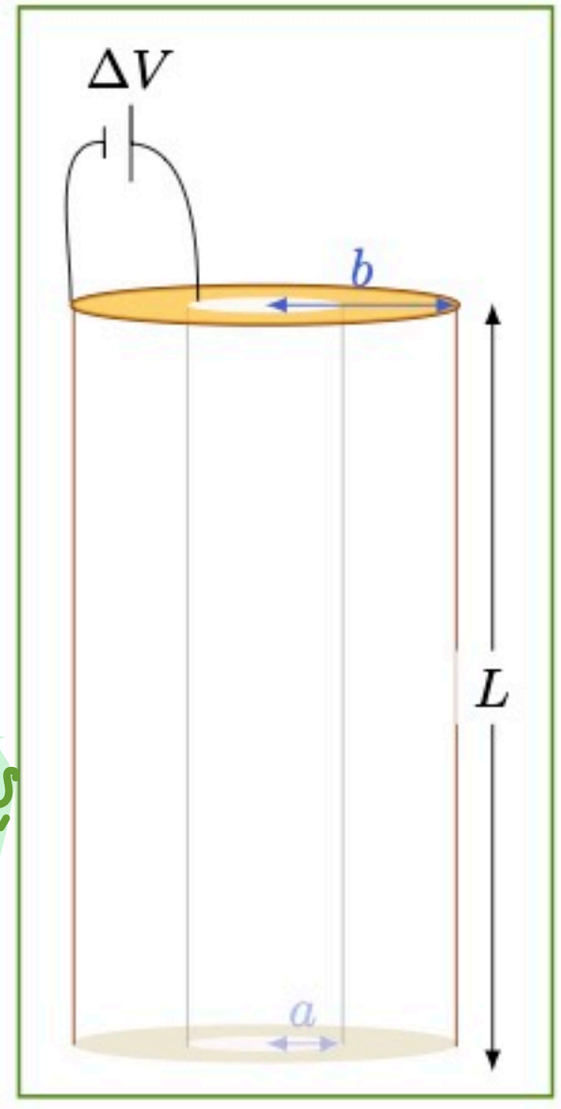
$$\Delta V = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{b}{a}\right)$$

$$\Delta V = \frac{Q}{2\pi\epsilon L}\log\left(\frac{b}{a}\right)$$

$$C = \frac{2\pi\epsilon L}{\log\left(\frac{b}{a}\right)}$$

$C = \frac{Q}{\Delta V}$

NÃO É O QUE QUEREMOS, MAS ABRIRÁ UMA DISCUSSÃO, DEPOIS

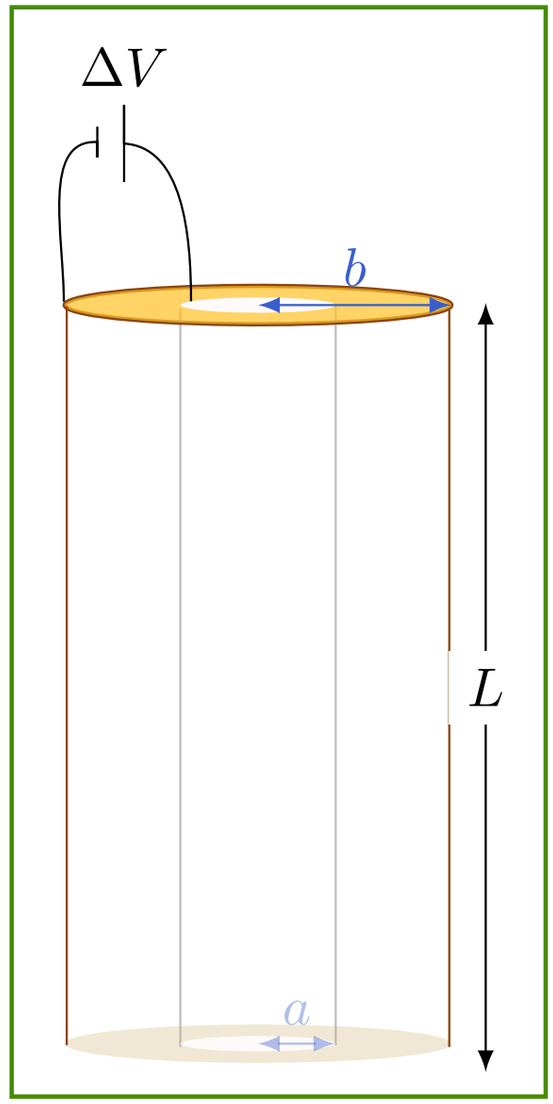


Pratique o que aprendeu

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

$I = ?$

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$



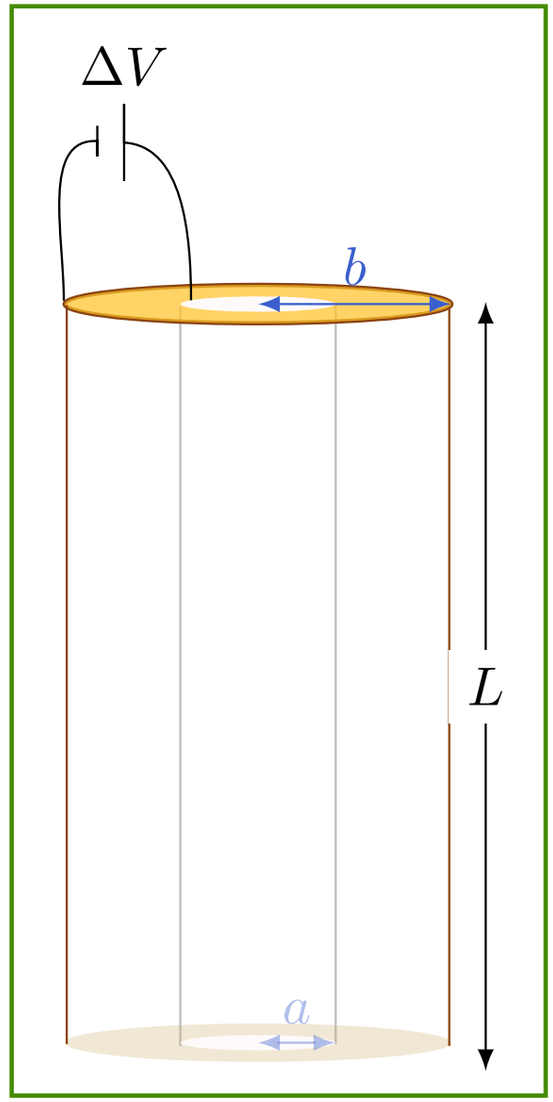
Pratique o que aprendeu

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

$I = ?$

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$\vec{J} = \sigma \vec{E}$ ➡ $\vec{J} = \frac{\sigma}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$



Pratique o que aprendeu

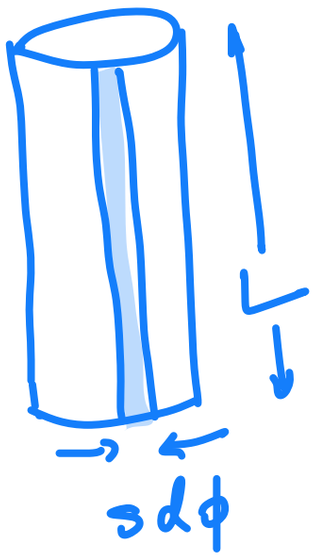
$$\vec{J} = \sigma \vec{E}$$

$$I = ?$$

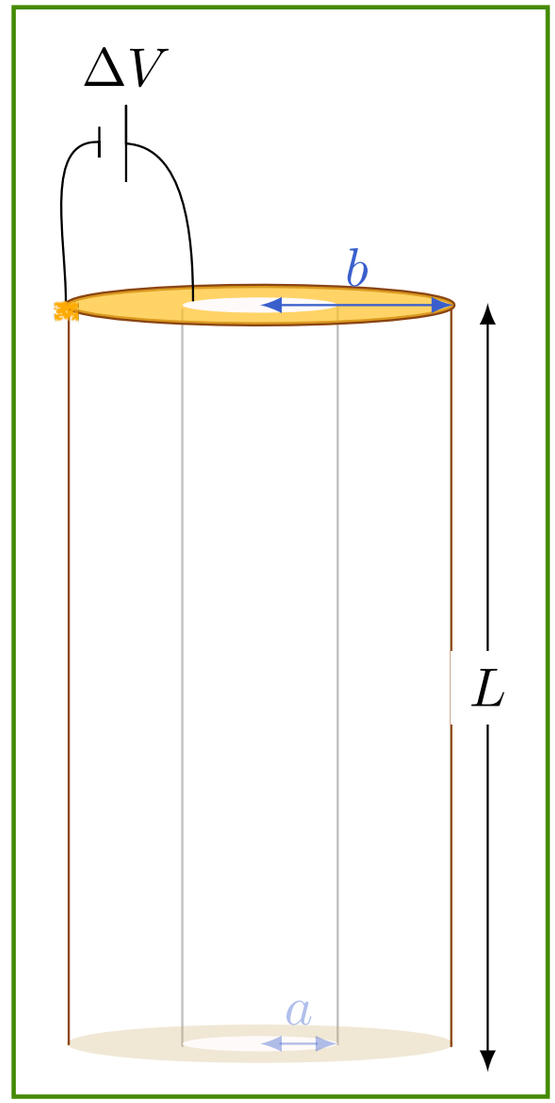
$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\vec{J} = \frac{\sigma}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$I = \int \frac{\sigma}{2\pi\epsilon}\frac{\lambda}{s}\,\mathrm{d}a$$



$da = L s d\phi$



Pratique o que aprendeu

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

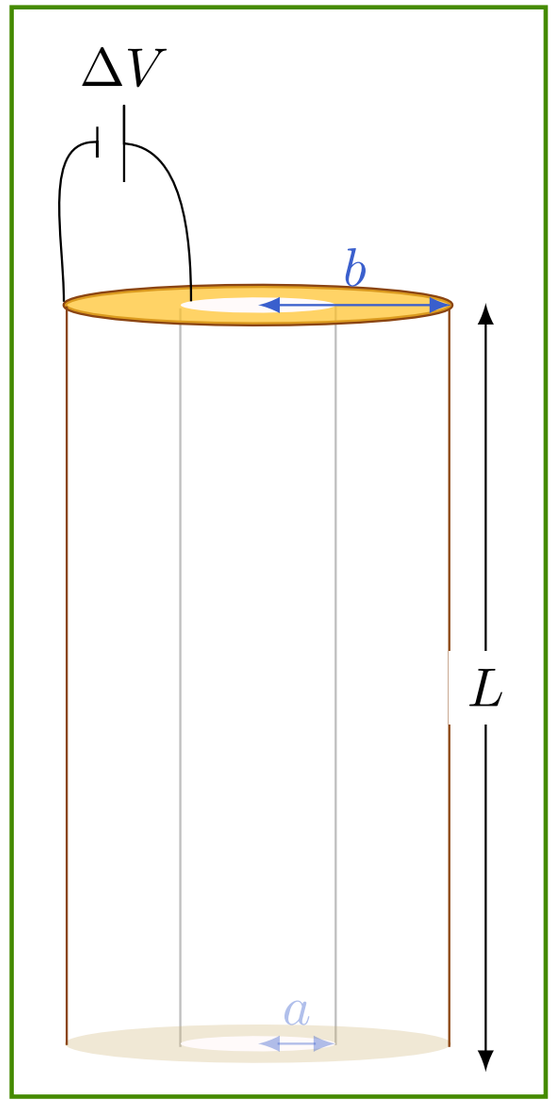
$$I = ?$$

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\vec{J} = \frac{\sigma}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$I = \int \frac{\sigma}{2\pi\epsilon}\frac{\lambda}{s}\,\mathrm{d}a$$

$$I = \frac{\sigma}{2\pi\epsilon}\lambda \int_0^{2\pi} \frac{Ls\,\mathrm{d}\phi}{s}$$



Pratique o que aprendeu

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

$$I = ?$$

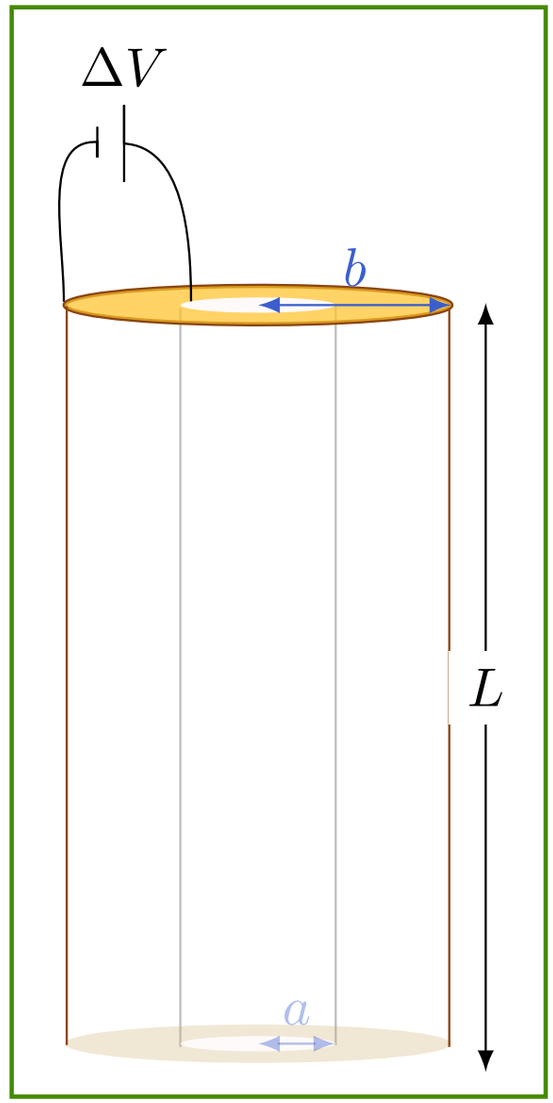
$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\vec{J} = \frac{\sigma}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$I = \int \frac{\sigma}{2\pi\epsilon}\frac{\lambda}{s}\,\mathrm{d}a$$

$$I = \frac{\sigma}{2\pi\epsilon}\lambda \int_0^{2\pi} \frac{L s\,\mathrm{d}\phi}{s}$$

$$\Rightarrow \quad I = \frac{\sigma}{\epsilon}\lambda L$$



Pratique o que aprendeu

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

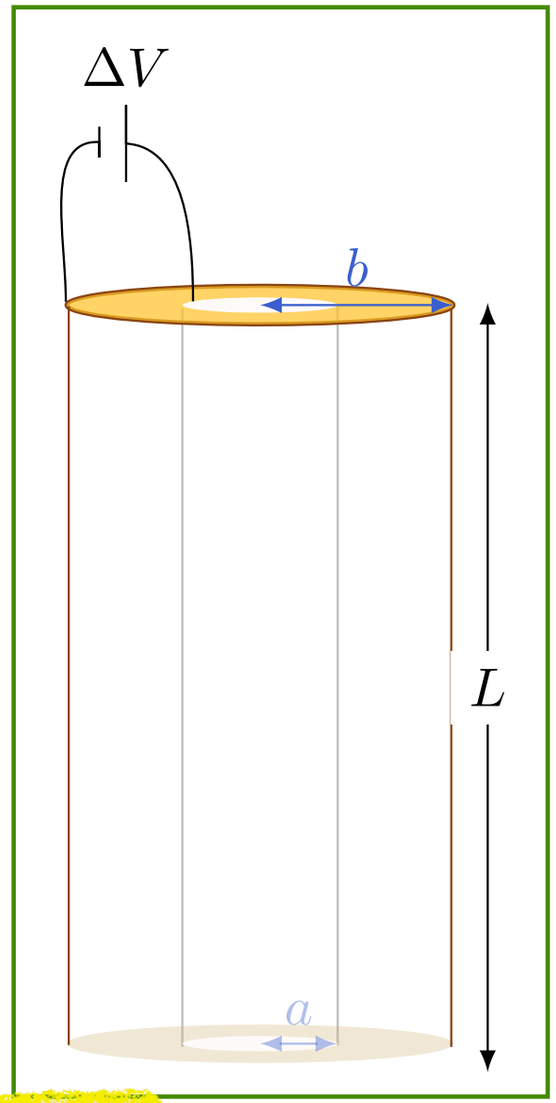
$$I = ?$$

$$\vec{E} = \frac{1}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$\vec{J} = \frac{\sigma}{2\pi\epsilon}\frac{\lambda \hat{s}}{s}$$

$$I = \int \frac{\sigma}{2\pi\epsilon}\frac{\lambda}{s}\,\mathrm{d}a$$

$$I = \frac{\sigma}{2\pi\epsilon}\lambda \int_0^{2\pi} \frac{L s\,\mathrm{d}\phi}{s}$$



$$\Rightarrow \quad I = \frac{\sigma}{\epsilon}\lambda L$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{b}{a}\right)$$

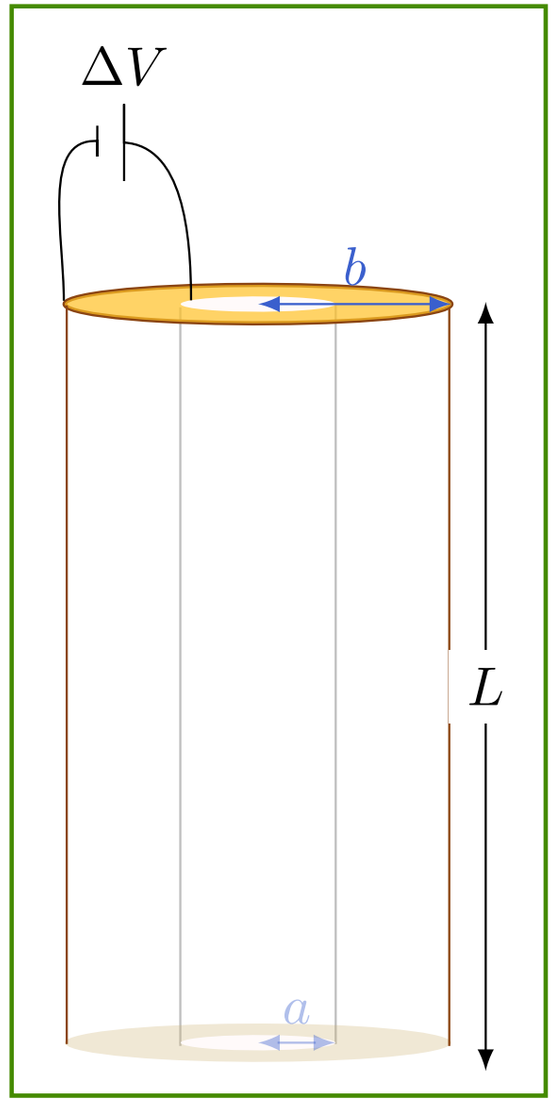
DA TELA

Pratique o que aprendeu

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

$$I = \frac{\sigma}{\epsilon} \lambda L$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon} \log\left(\frac{b}{a}\right)$$



Pratique o que aprendeu

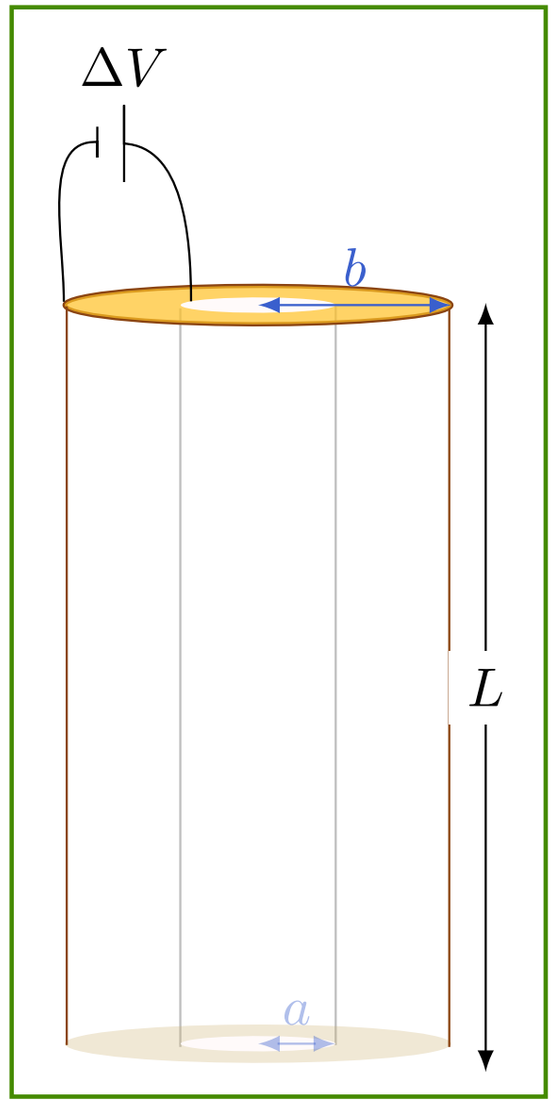
$$\vec{J} = \sigma \vec{E}$$

$$I = \frac{\sigma}{\epsilon} \lambda L$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon} \log\left(\frac{b}{a}\right)$$

$\Delta V = RI$

$$R = \frac{1}{2\pi\sigma L} \log\left(\frac{b}{a}\right)$$



Pratique o que aprendeu

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

$$I = ?$$

$$\Rightarrow \quad I = \frac{\sigma}{\epsilon_0} \lambda L$$

$$\Rightarrow \quad \Delta V = \frac{\lambda}{2\pi\epsilon_0} \log\left(\frac{b}{a}\right)$$

$$\Delta V = \frac{I}{2\pi\sigma L} \log\left(\frac{b}{a}\right)$$

$$R = \frac{1}{2\pi\sigma L} \log\left(\frac{b}{a}\right)$$

ΔV

Pratique o que aprendeu

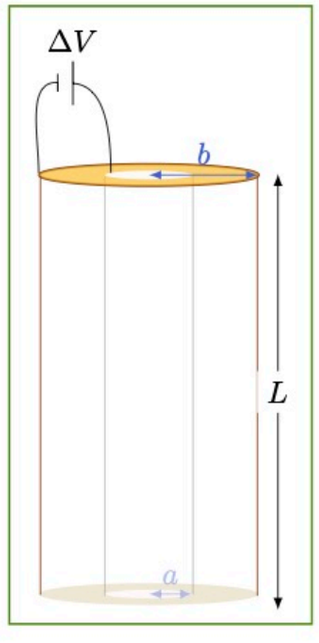
$\vec{J} = \sigma \vec{E}$

$$\vec{E} = \frac{1}{2\pi\epsilon} \frac{\lambda \hat{s}}{s}$$

$$\Delta V = \frac{\lambda}{2\pi\epsilon} \log\left(\frac{b}{a}\right)$$

$$\Delta V = \frac{Q}{2\pi\epsilon L} \log\left(\frac{b}{a}\right)$$

$$C = \frac{2\pi\epsilon L}{\log\left(\frac{b}{a}\right)}$$



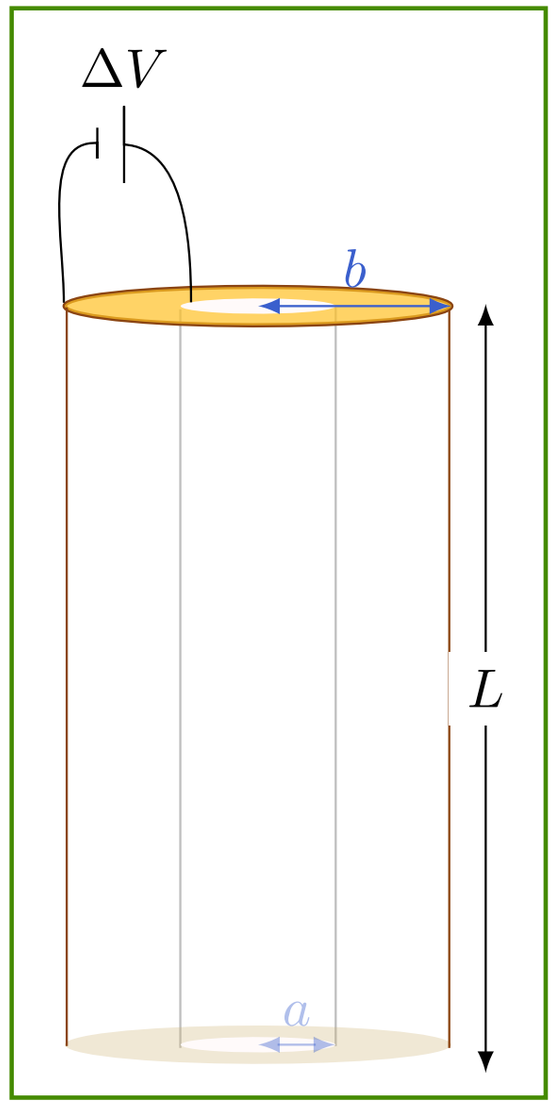
TELA 9

Pratique o que aprendeu

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

$$R = \frac{1}{2\pi\sigma L} \log\left(\frac{b}{a}\right)$$

$$C = \frac{2\pi\epsilon L}{\log\left(\frac{b}{a}\right)}$$



Pratique o que aprendeu

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

$$R = \frac{1}{2\pi\sigma L} \log\left(\frac{b}{a}\right)$$

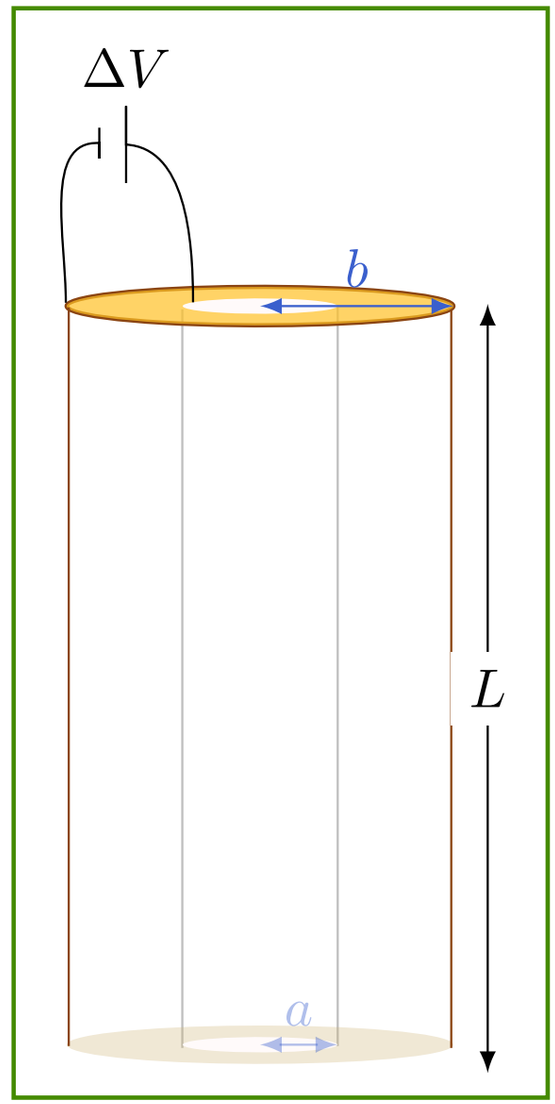
$$C = \frac{2\pi\epsilon L}{\log\left(\frac{b}{a}\right)}$$

$$RC = \frac{\epsilon}{\sigma}$$

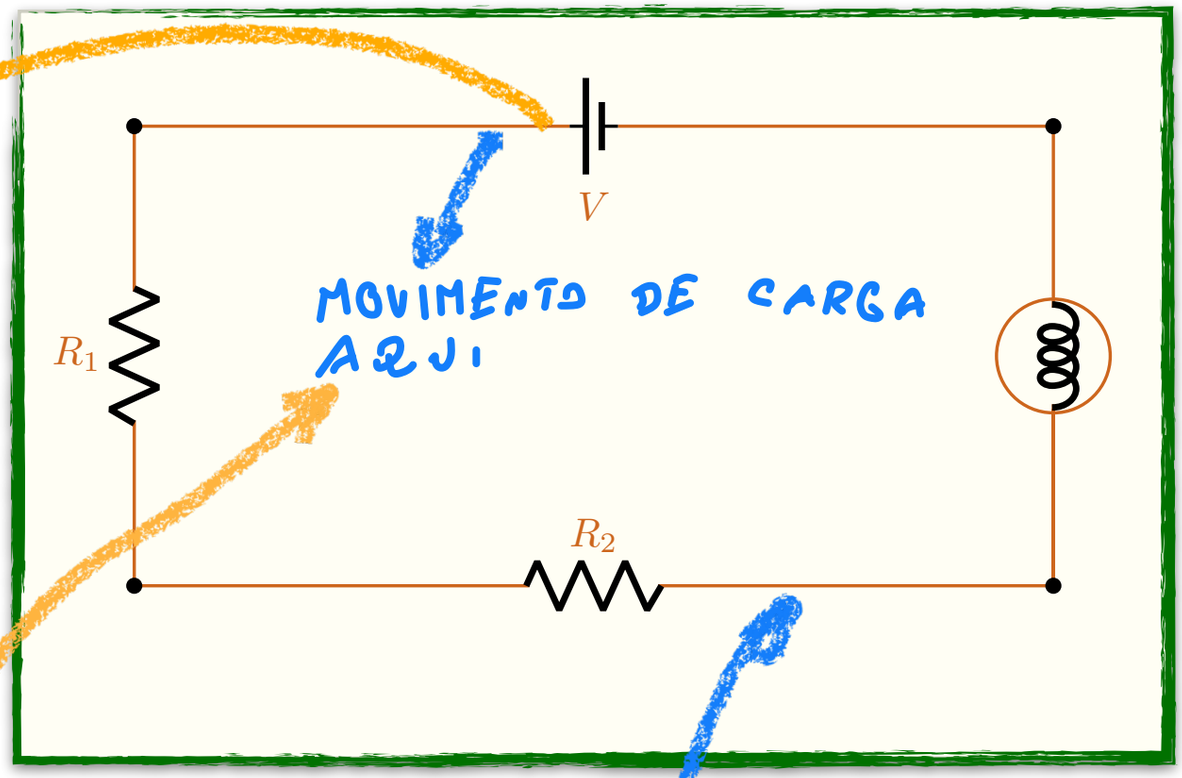
INDEPENDE DA GEOMETRIA

TEMPO CARACTERÍSTICO

CURTÍSSIMO, PARA BOM CONDUTOR
$RC \sim 10^{-18}$ s, PARA Cu



Eletrodinâmica
Força eletromotriz



SE HOUVER QUALQUER ACÚMULO DE CARGA, O CORRERÁ DISSIPAÇÃO NA ESCALA DE TEMPO ε/σ

MOVIMENTO DE CARGA AQUI

BEM, SE PONTOS FORÉM MUITO DISTANTES, PROPAGAÇÃO SERÁ EM ESCALA DE TEMPO MENOR, PQ NÃO PODE PASSAR DA VELOCIDADE DA LUZ

CASO CONTRÁRIO, HAVERIA ACÚMULO DE CARGA EM ALGUM LUGAR

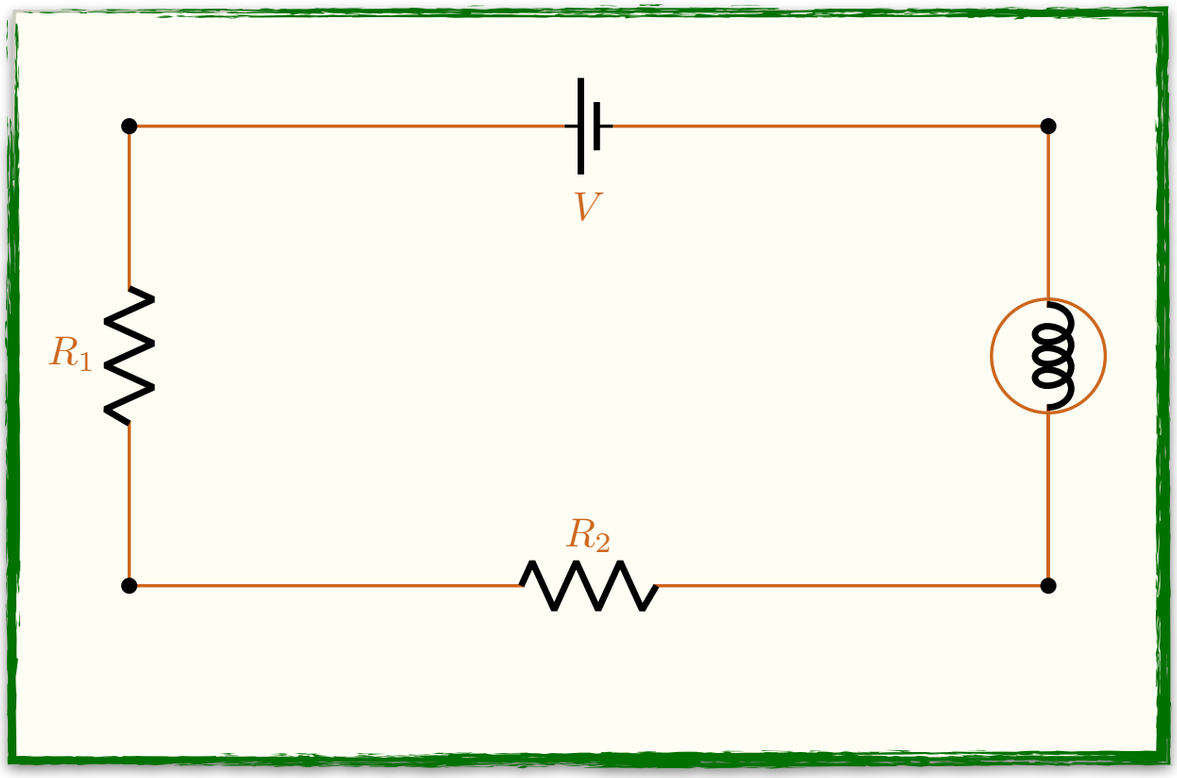
CERA MOVIMENTO DE CARGA AQUI, NA ESCALA DE TEMPO ε/σ

Eletrodinâmica
Força eletromotriz

SOMENTE DENTRO DA BATERIA

$$\vec{f} = \vec{f}_{\text{bat}} + \vec{E}$$

FORÇA TOTAL SOBRE UMA CARGA NO CIRCUITO



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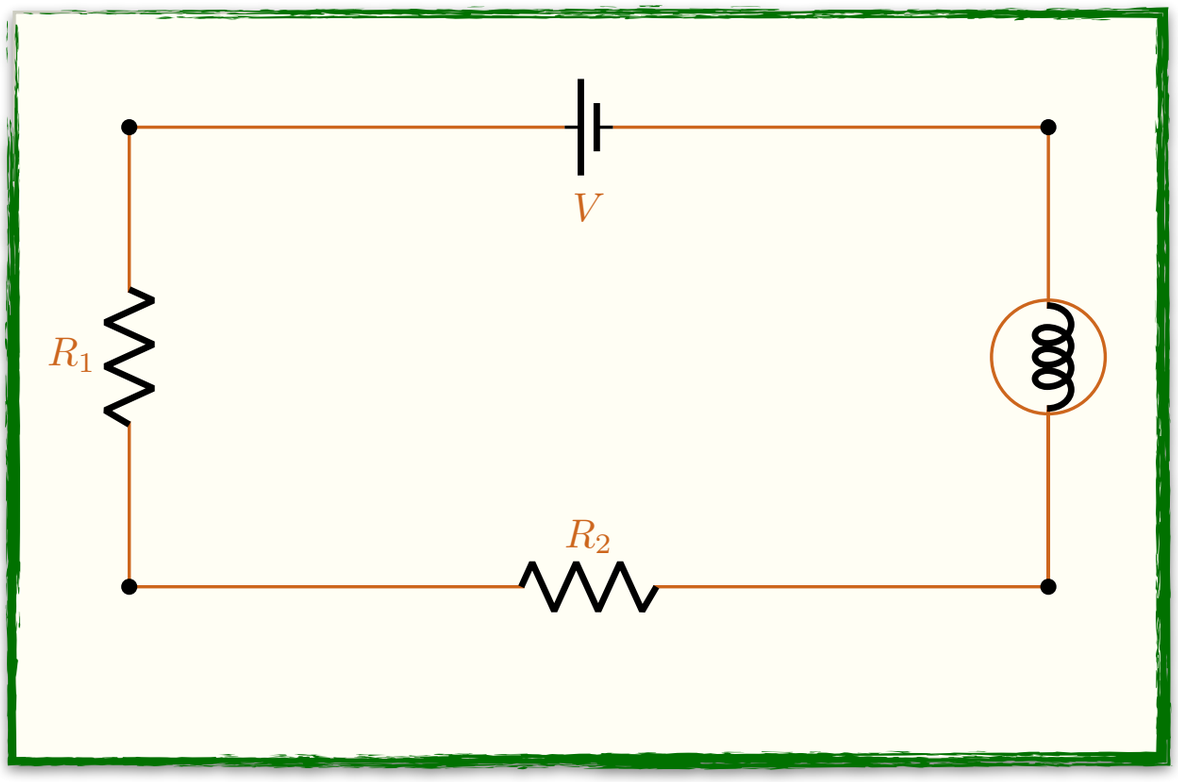
$$\vec{f} = \vec{f}_{\text{bat}} + \vec{E}$$

$$\oint \vec{f} \cdot \mathrm{d}\vec{\ell} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell} + \oint \vec{E} \cdot \mathrm{d}\vec{\ell}$$

0

CIRCUITO TODO, INCLUSIVE DENTRO DA BATERIA



Eletrodinâmica
Força eletromotriz

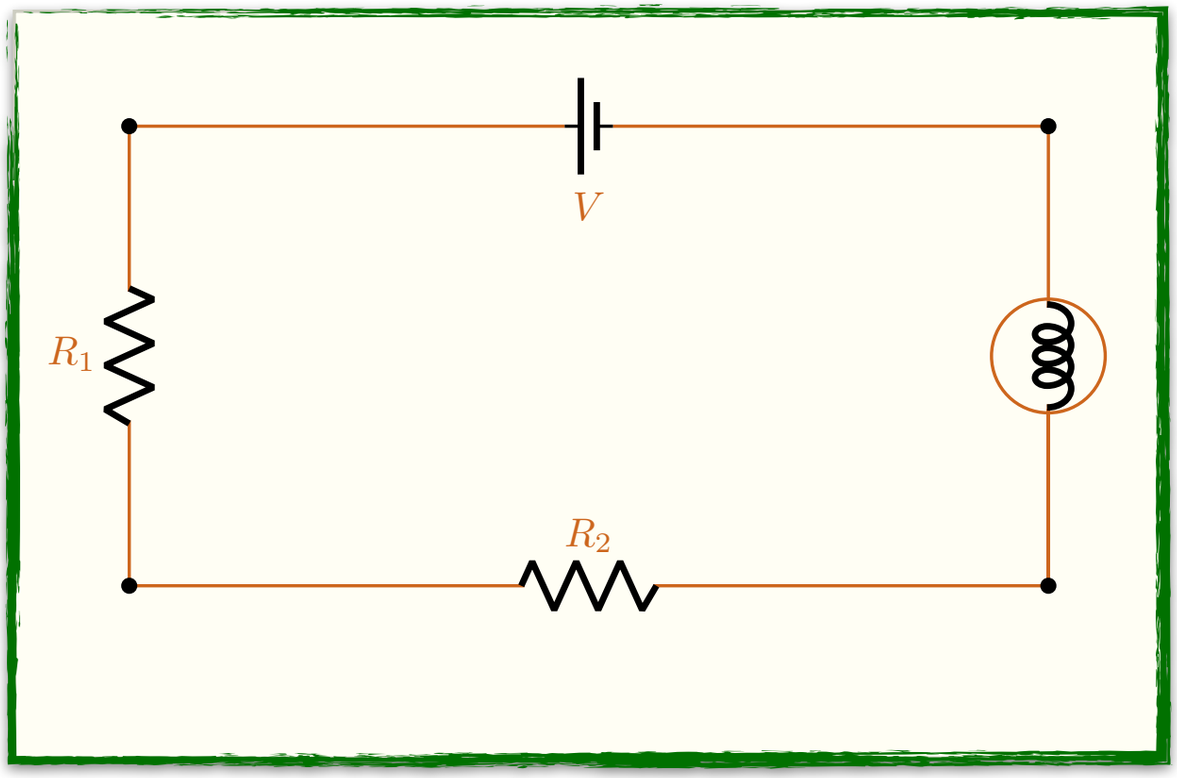
$$\vec{f} = \vec{f}_{\text{bat}} + \vec{E}$$

$$\oint \vec{f} \cdot \mathrm{d}\vec{\ell} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell} + \oint \vec{E} \cdot \mathrm{d}\vec{\ell}$$

$$\mathcal{E} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell}$$

DIFERENÇA DE POTENCIAL QUE MOVIMENTA AS CARGAS

FORÇA ELETROMOTRIZ



Eletrodinâmica
Força eletromotriz

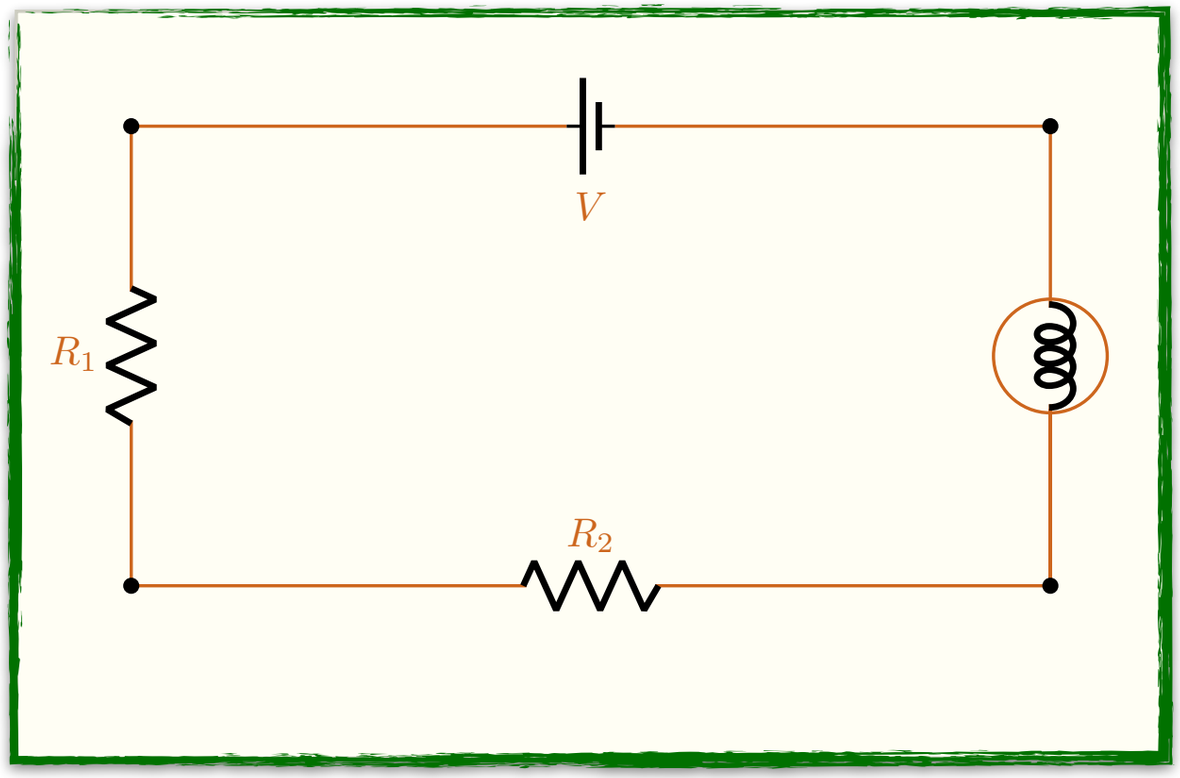
$$\vec{f} = \vec{f}_{\text{bat}} + \vec{E}$$

$$\oint \vec{f} \cdot \mathrm{d}\vec{\ell} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell} + \oint \vec{E} \cdot \mathrm{d}\vec{\ell}$$

$$\mathcal{E} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell}$$

Dentro da bateria

$$\vec{E}_{\text{bat}} + \vec{f}_{\text{bat}} \approx 0$$



Eletrodinâmica
Força eletromotriz

$$\vec{f} = \vec{f}_{\text{bat}} + \vec{E}$$

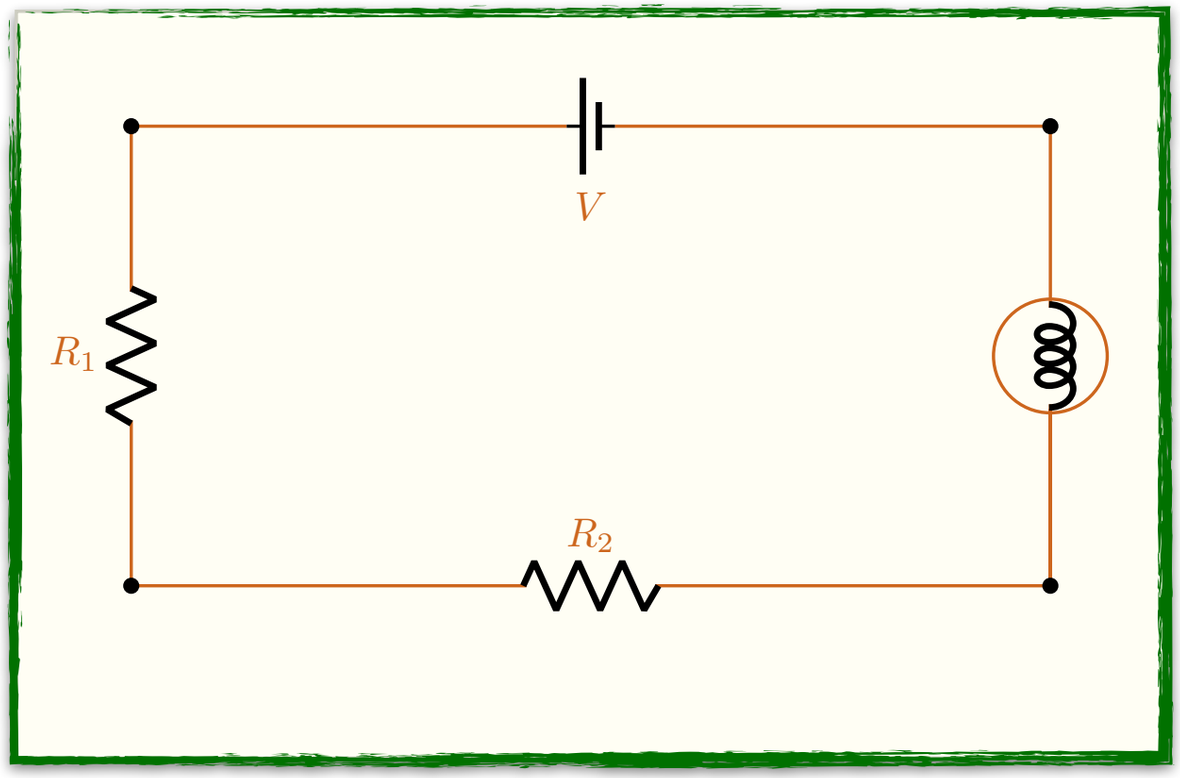
$$\oint \vec{f} \cdot \mathrm{d}\vec{\ell} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell} + \oint \vec{E} \cdot \mathrm{d}\vec{\ell}$$

$$\mathcal{E} = \oint \vec{f}_{\text{bat}} \cdot \mathrm{d}\vec{\ell}$$

Dentro da bateria

$$\vec{E}_{\text{bat}} + \vec{f}_{\text{bat}} \approx 0$$

$$\mathcal{E} = -\oint \vec{E}_{\text{bat}} \cdot \mathrm{d}\vec{\ell}$$



Eletrodinâmica
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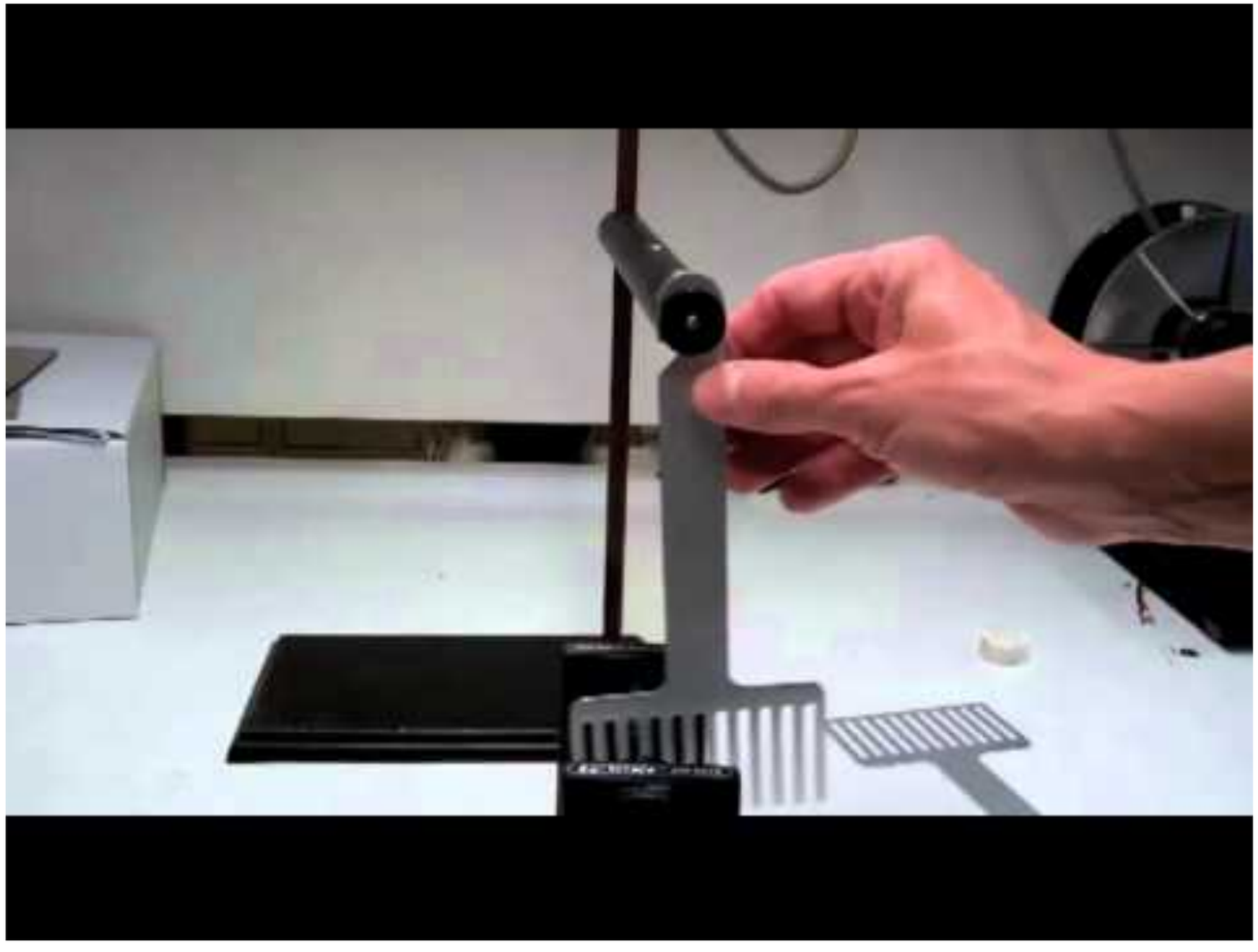
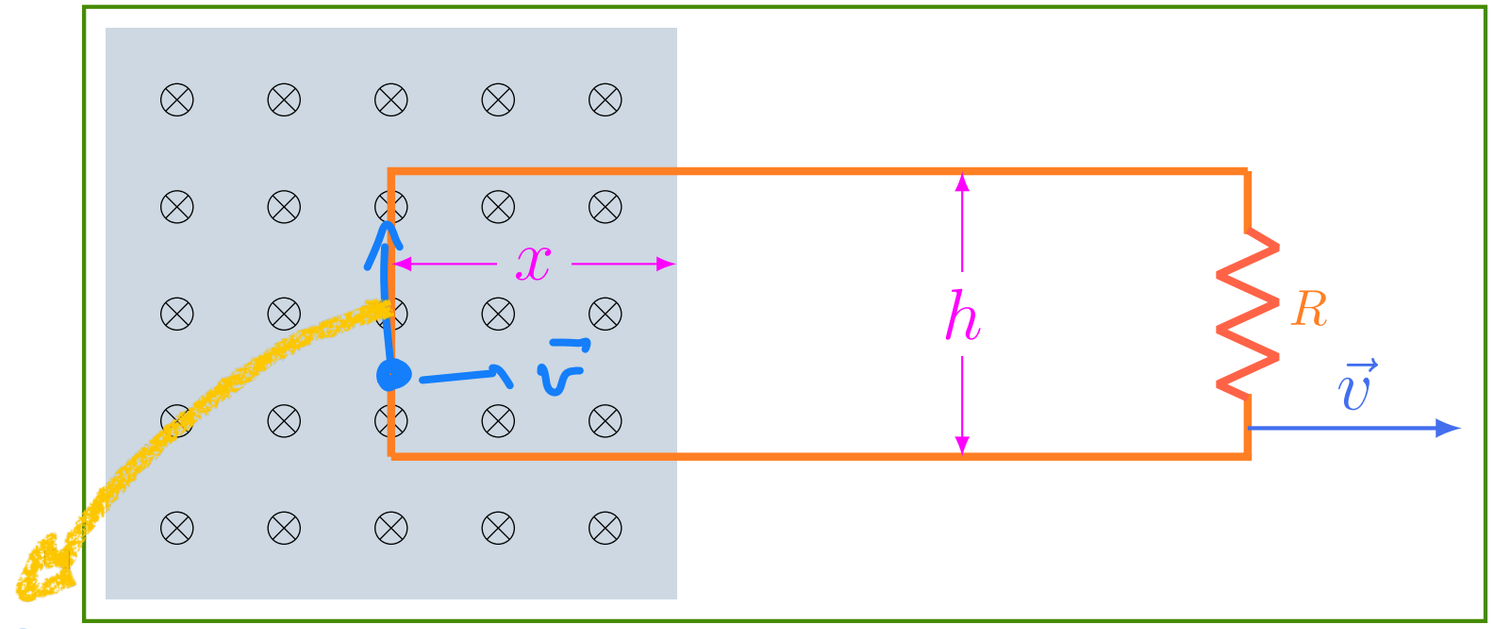
- OUTRA FONTE DE FORÇA ELETROMOTRIZ



https://www.youtube.com/watch?v=MglUIiBy2lQ

Eletrodinâmica
Força eletromotriz

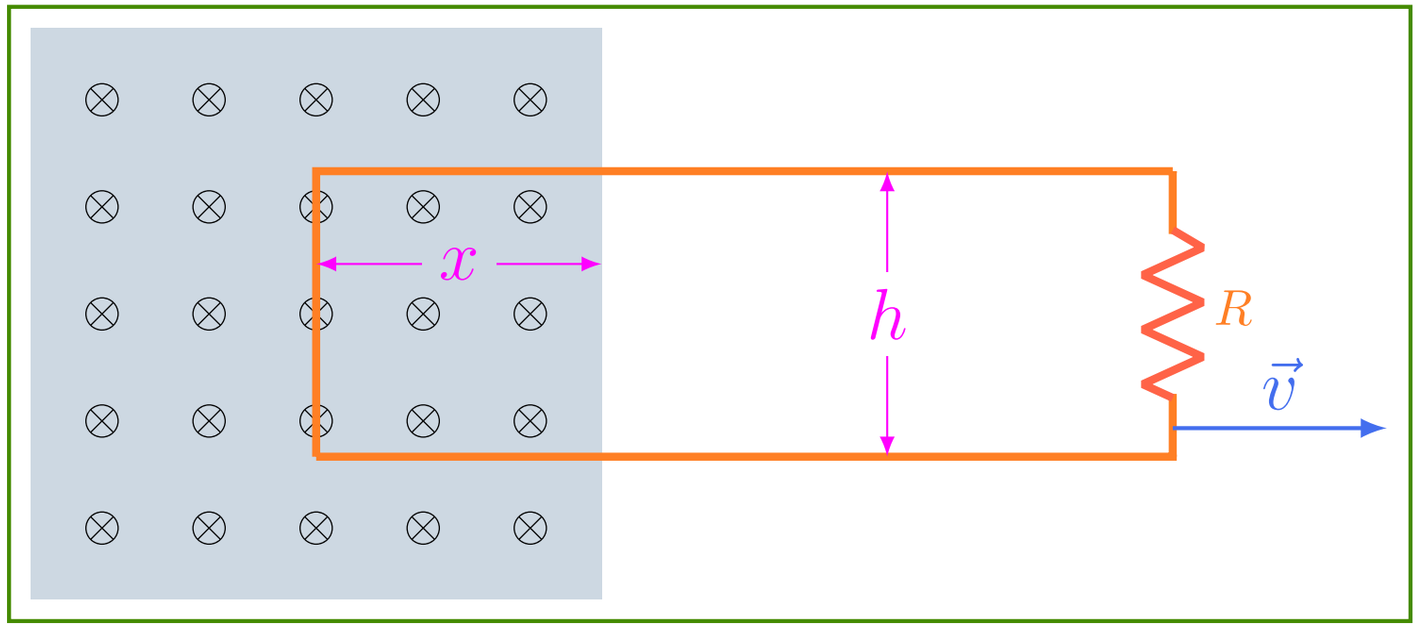


FORÇA
DE
LORENTZ

Eletrodinâmica
Força eletromotriz

$F = q\ \vec{v} \times \vec{B}$

$$\mathcal{E} = \int_{\text{vert}} \vec{v} \times \vec{B} \cdot \mathrm{d}\vec{\ell}$$

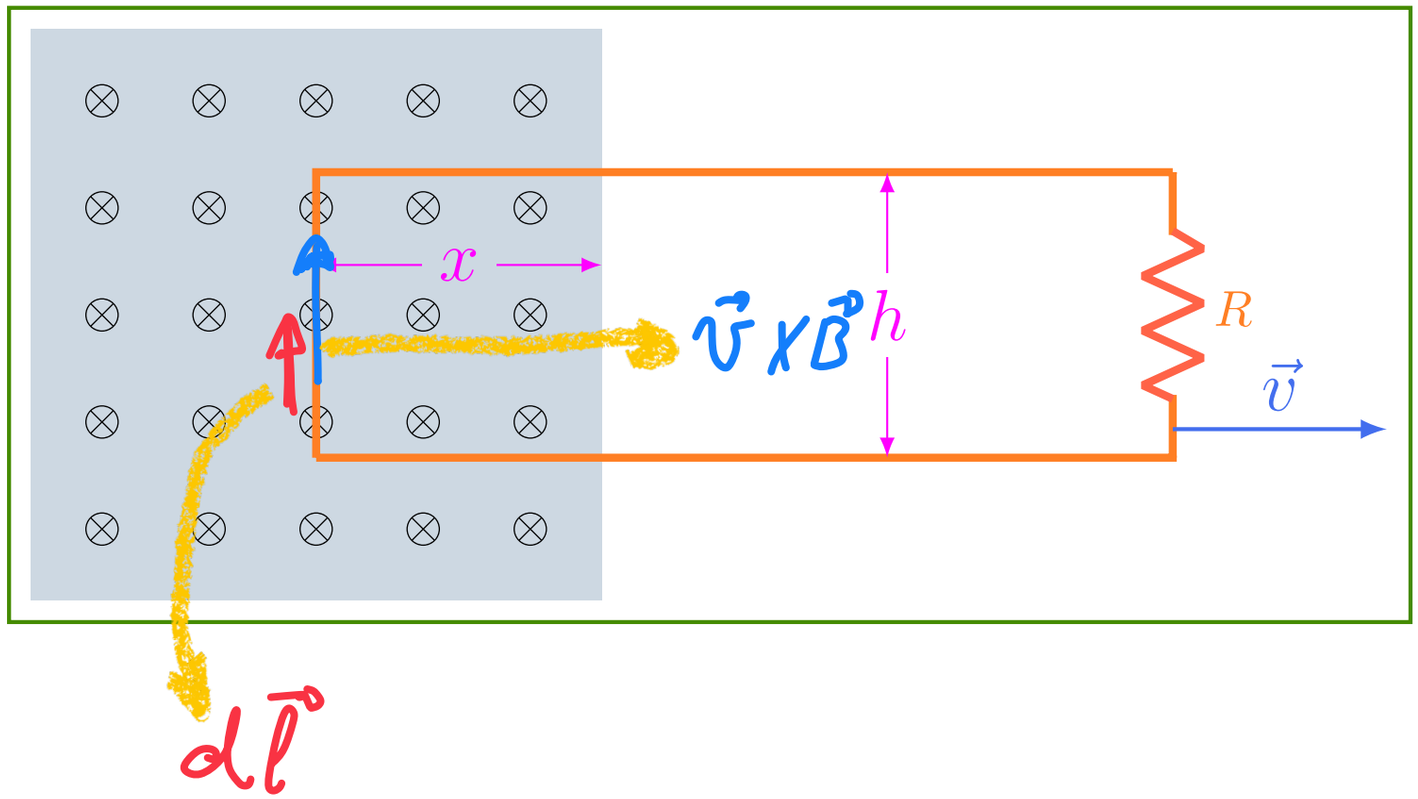


Eletrodinâmica
Força eletromotriz

$$\mathcal{E} = \int_{\text{vert}} \vec{v} \times \vec{B} \cdot \mathrm{d}\vec{\ell}$$

$$\mathcal{E} = vBh$$

$\vec{v} \times \vec{B} \;//\; d\vec{\ell}$



Eletrodinâmica
Força eletromotriz

$$\mathcal{E} = \int_{\text{vert}} \vec{v} \times \vec{B} \cdot \mathrm{d}\vec{\ell}$$

$$\mathcal{E} = vBh \longrightarrow \phi = Bxh$$

$$\mathcal{E} = -\frac{\mathrm{d}\phi}{\mathrm{d}t}$$