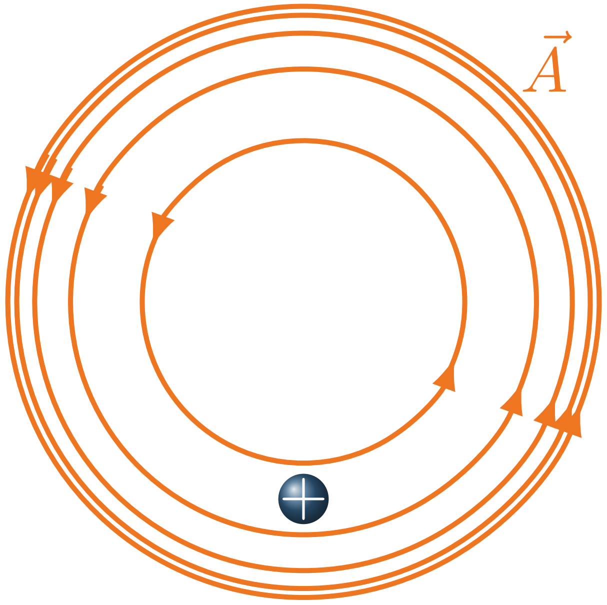
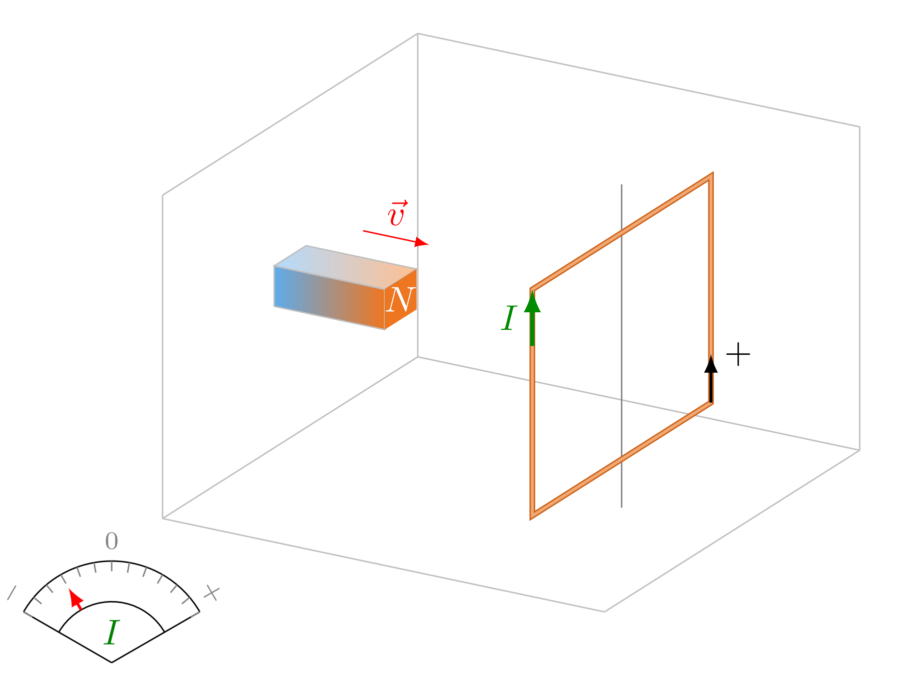
Física III

Aula *remota de 30/06/2020*
A lei de Faraday e o potencial vetor



A lei de Faraday

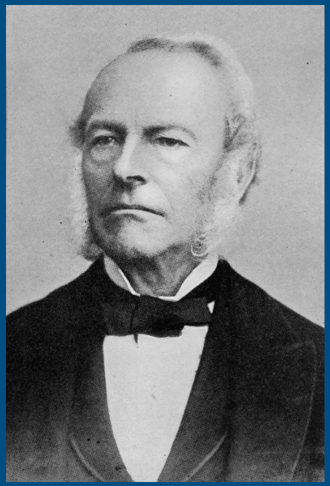
$$\int_C \vec{E} \cdot \mathrm{d}\vec{\ell} = -\frac{d\Phi}{dt}$$



$$\phi = \int_S \vec{B} \cdot \hat{n}\, \mathrm{d}S$$

$$\phi = \int_S \vec{\nabla} \times \vec{A} \cdot \hat{n}\, \mathrm{d}S$$

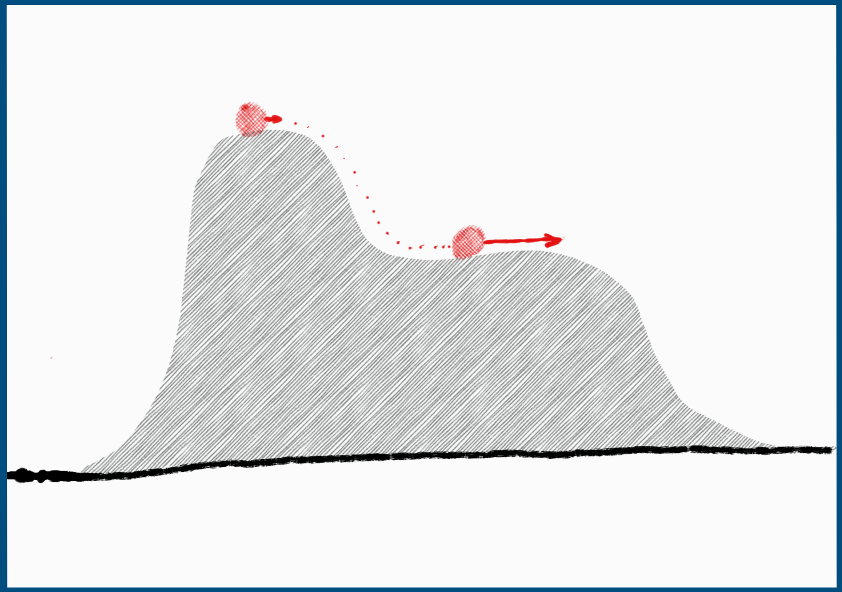
$$\phi = \int_C \vec{A} \cdot \mathrm{d}\vec{\ell}$$



wikipedia

$$\vec{E} = -\frac{\partial \vec{A}}{\partial t}$$

Potencial

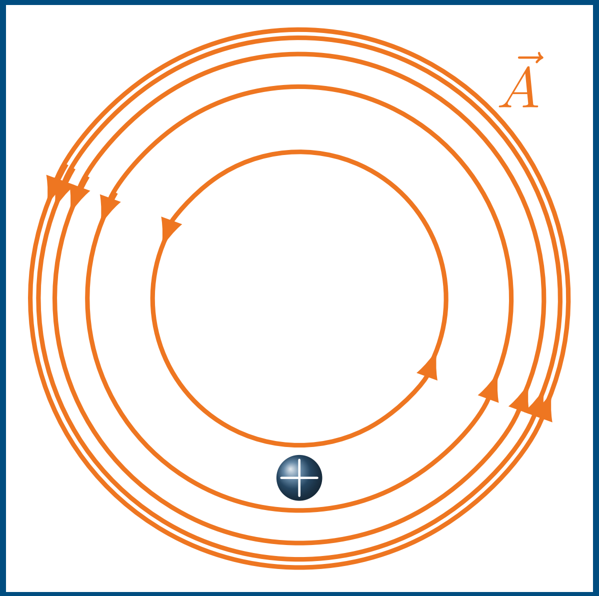


$$\vec{E} = -\vec{\nabla} V$$

$$E_{\text{mec}} = \frac{1}{2}mv^2 + qV$$

$$\frac{mv_P^2}{2} + qV_P = \frac{mv_{P'}^2}{2} + qV_{P'}$$

Potencial vetor



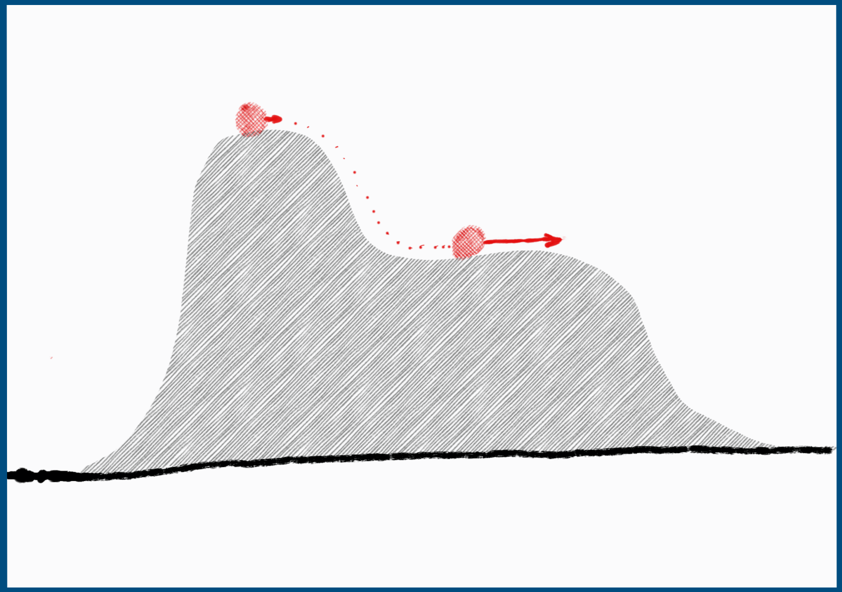
$$\vec{B} = \vec{\nabla} \times \vec{A}$$

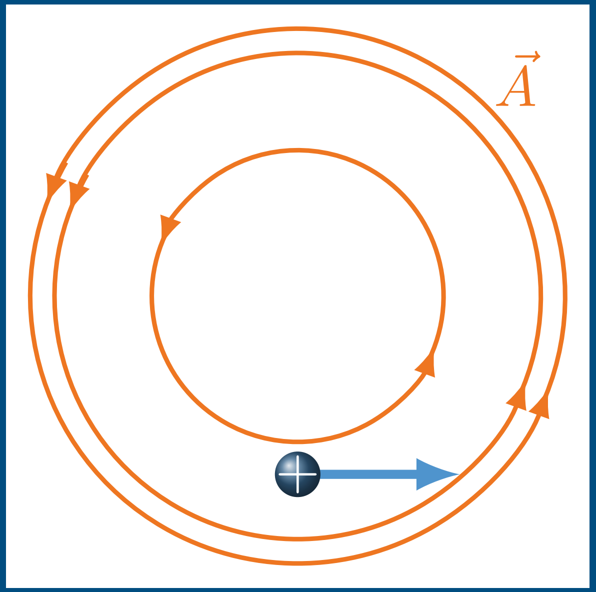
$$\vec{p} = m\vec{v} + q\vec{A}$$

$$m\vec{v}(t) + q\vec{A}(t) = m\vec{v}(t') + q\vec{A}(t')$$

Potencial

Potencial vetor



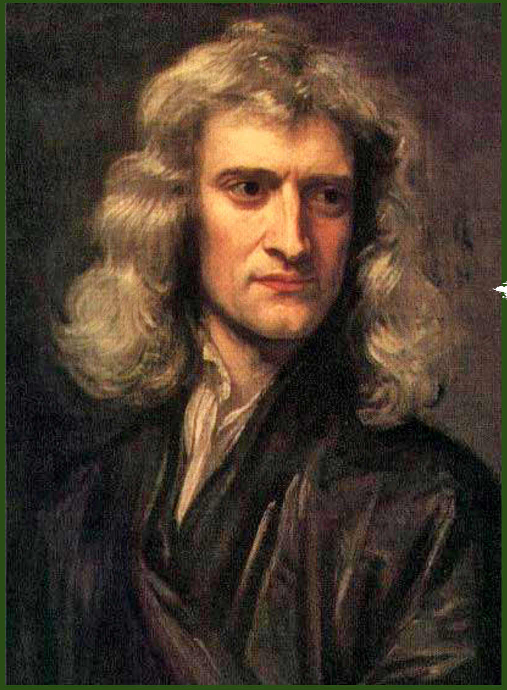


$$\vec{E} = -\vec{\nabla} V \qquad \vec{B} = \vec{\nabla} \times \vec{A}$$

$$E_{\text{mec}} = \frac{1}{2} m v^2 + qV \qquad \vec{p} = m\vec{v} + q\vec{A}$$

$$\frac{m v_P^2}{2} + qV_P = \frac{m v_{P'}^2}{2} + qV_{P'} \qquad m\vec{v}(t) + q\vec{A}(t) = m\vec{v}(t') + q\vec{A}(t')$$

$$\frac{dp_x}{dt} = -\frac{\partial E_m}{\partial x}$$

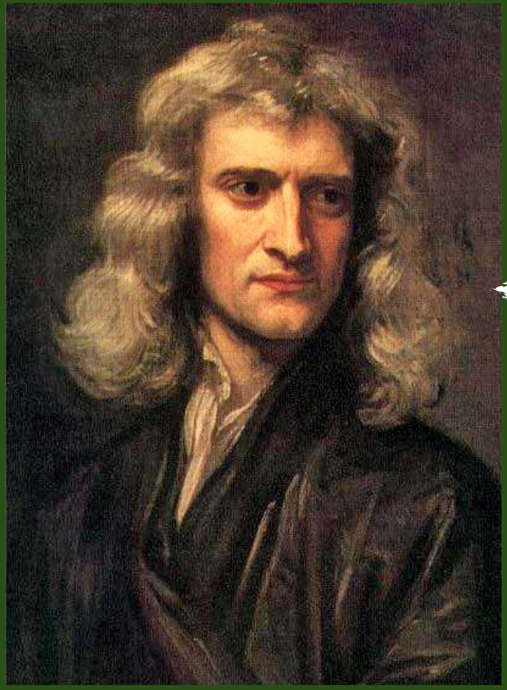


wikipedia

$$\frac{dp_x}{dt} = F_x$$

$$F_x = -\frac{\partial U}{\partial x}$$

$$\frac{d\vec{p}}{dt} = -\vec{\nabla} E_m$$



wikipedia

$$\frac{d\vec{p}}{dt} = \vec{F}$$

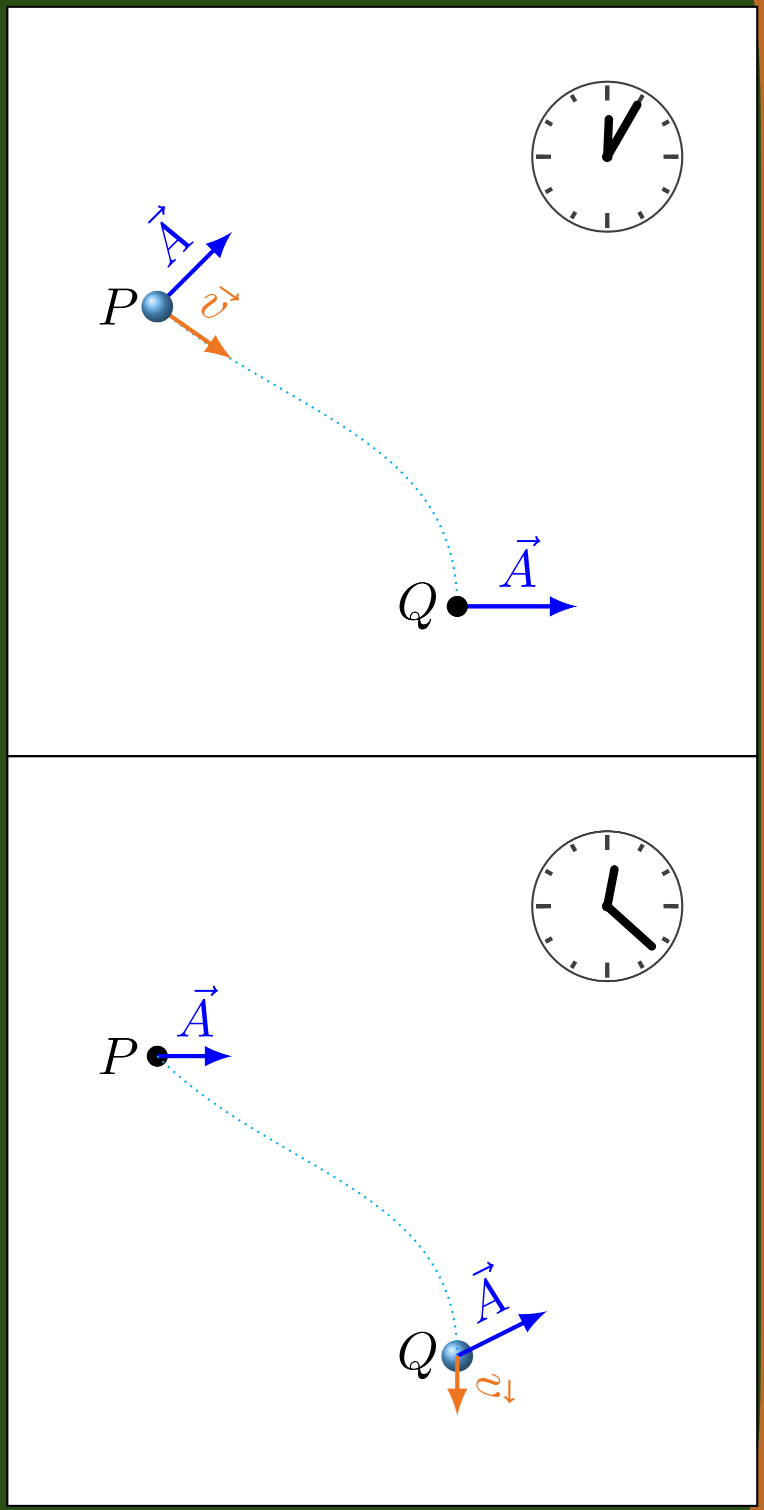
$$\vec{F} = -\vec{\nabla} U$$

- $$\frac{dp_x}{dt} = -\frac{\partial E_m}{\partial x}$$

- $$p_x = mv_x + qA_x(x, y, z, t)$$

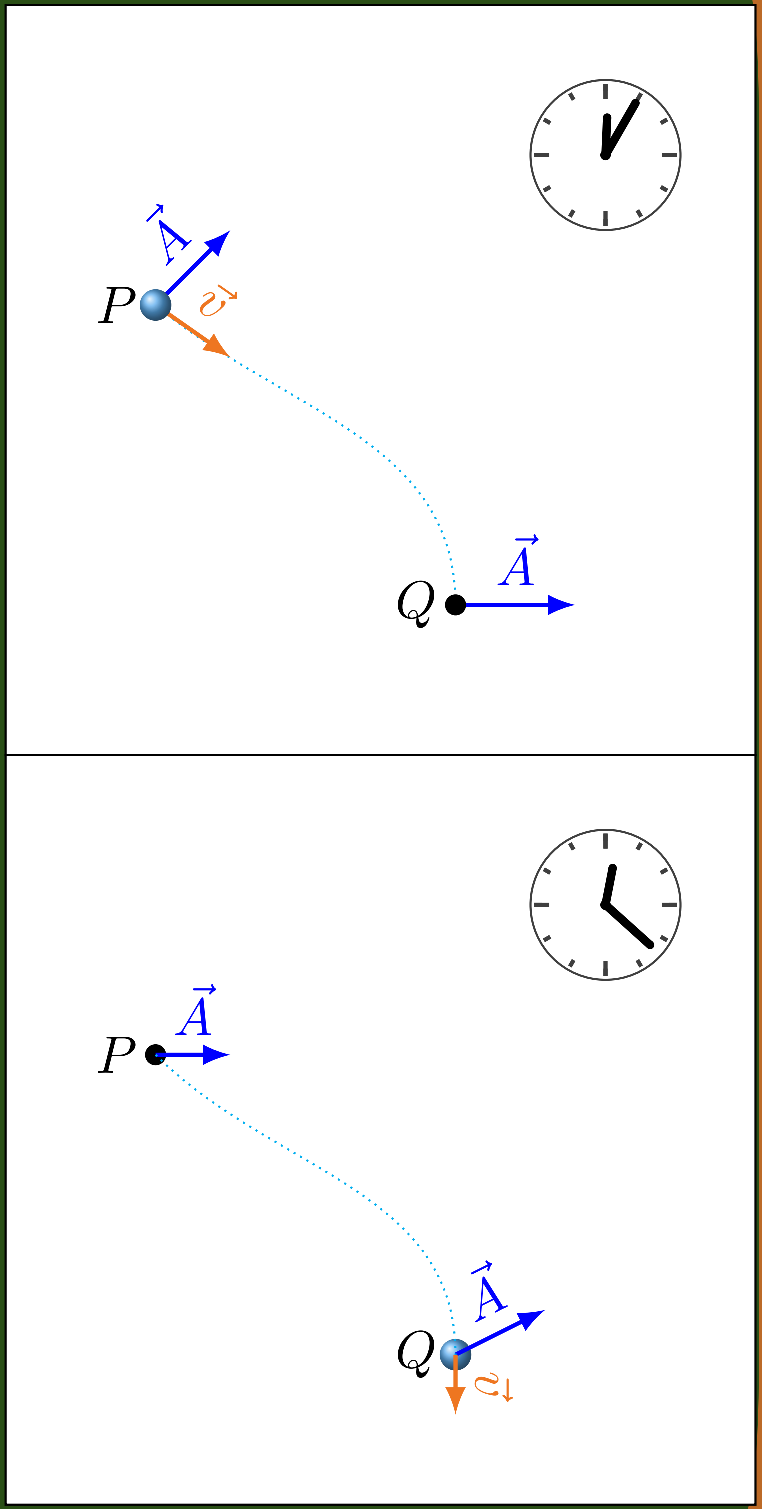
- $$E_m = \frac{1}{2m}(\overrightarrow{p} - q\overrightarrow{A})^2 + qV$$

$$p_x = mv_x + qA_x(x, y, z, t)$$



$$p_x = mv_x + qA_x(x, y, z, t)$$

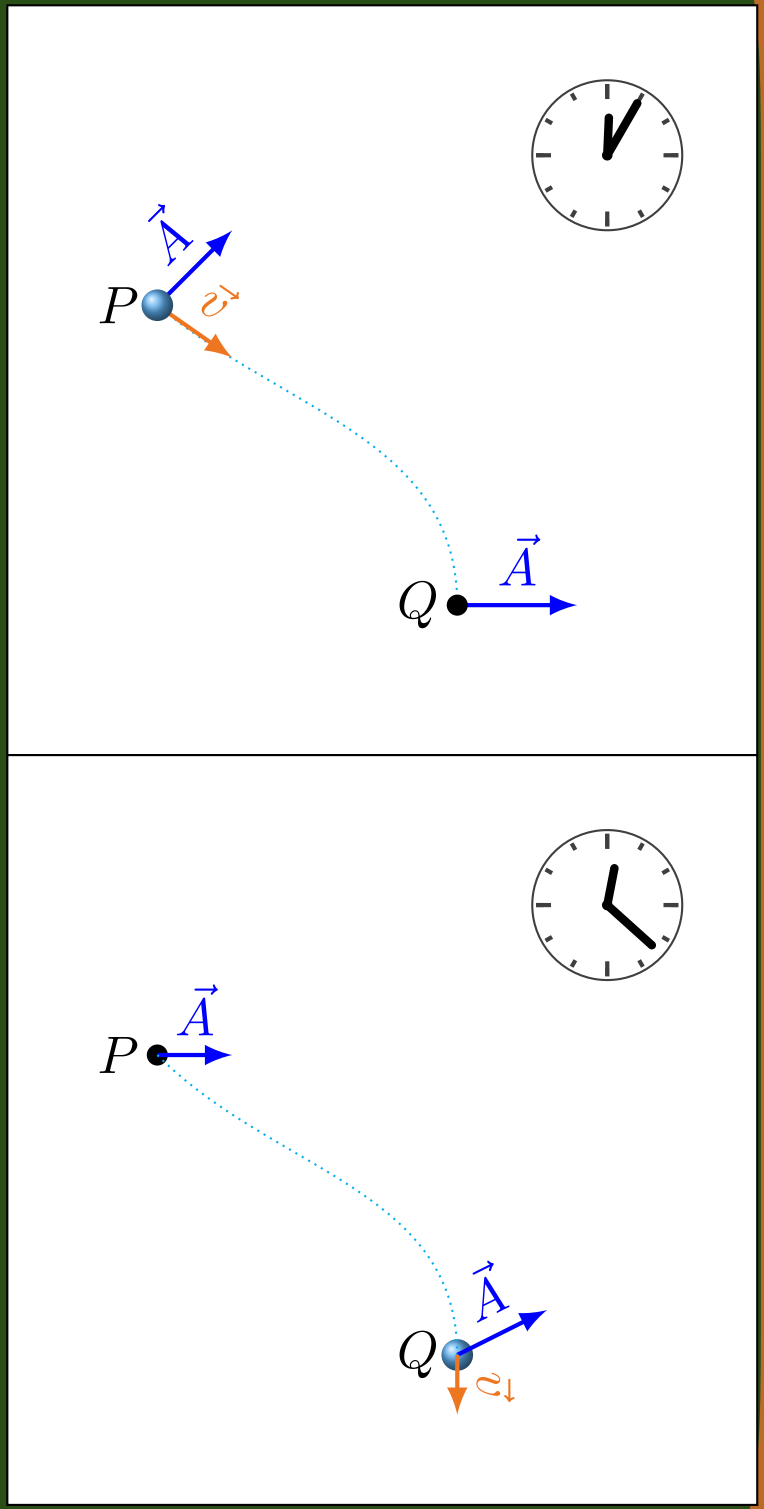
$$\frac{dp_x}{dt} = ma_x + q\frac{dA_x}{dt}$$



$$p_x = mv_x + qA_x(x, y, z, t)$$

$$\frac{dp_x}{dt} = ma_x + q\frac{dA_x}{dt}$$

$$dA_x = \frac{\partial A_x}{\partial x}dx + \frac{\partial A_x}{\partial y}dy + \frac{\partial A_x}{\partial z}dz + \frac{\partial A_x}{\partial t}dt$$

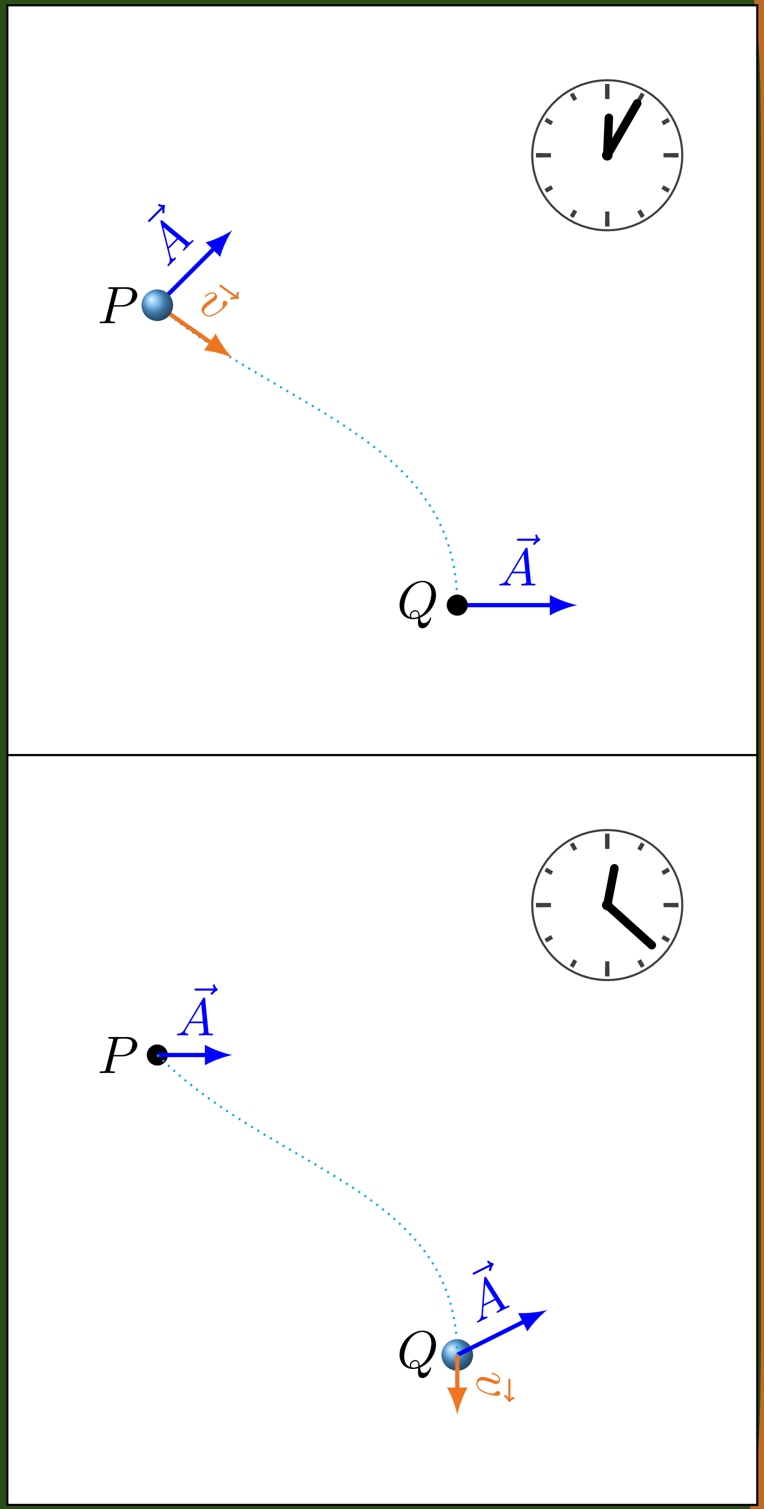


$$p_x = mv_x + qA_x(x, y, z, t)$$

$$\frac{dp_x}{dt} = ma_x + q\frac{dA_x}{dt}$$

$$dA_x = \frac{\partial A_x}{\partial x}dx + \frac{\partial A_x}{\partial y}dy + \frac{\partial A_x}{\partial z}dz + \frac{\partial A_x}{\partial t}dt$$

$$\frac{dA_x}{dt} = \frac{\partial A_x}{\partial x}\frac{dx}{dt} + \frac{\partial A_x}{\partial y}\frac{dy}{dt} + \frac{\partial A_x}{\partial z}\frac{dz}{dt} + \frac{\partial A_x}{\partial t}$$



- $$\frac{dp_x}{dt} = -\frac{\partial E_m}{\partial x}$$

- $$\overrightarrow{p} = m\overrightarrow{v} + q\overrightarrow{A}(x, y, z, t)$$

- $$E_m = \frac{1}{2m}(\overrightarrow{p} - q\overrightarrow{A})^2 + qV$$

$$ma_x = q\left[v_y\left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right) - v_z\left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right)\right] - q\left(\frac{\partial V}{\partial x} + \frac{\partial A_x}{\partial t}\right)$$

- $$\frac{dp_x}{dt} = -\frac{\partial E_m}{\partial x}$$

- $$\overrightarrow{p} = m\overrightarrow{v} + q\overrightarrow{A}(x, y, z, t)$$

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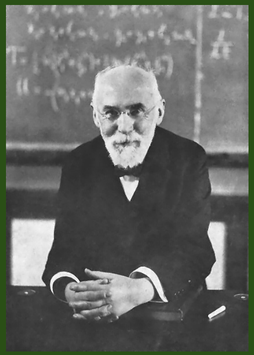
$$ma_x = q\left[v_y\underbrace{\left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)}_{B_z} - v_z\underbrace{\left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right)}_{B_y}\right] - q\underbrace{\left(\frac{\partial V}{\partial x} + \frac{\partial A_x}{\partial t}\right)}_{E_x}$$

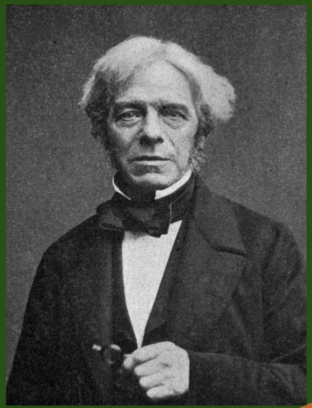
$$ma_x = m\left[\underbrace{v_y\left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)}_{B_z} - \underbrace{v_z\left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right)}_{B_y}\right] - q\left(\frac{\partial V}{\partial x} + \frac{\partial A_x}{\partial t}\right)$$



Lorentz

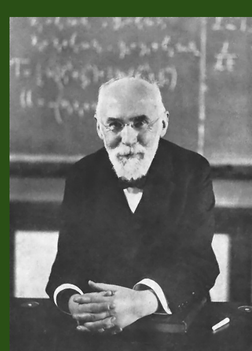
Coulomb

Faraday



wikipedia

$$m\vec{a} = q\left[\vec{v}\times\vec{B} - \left(\vec{\nabla}V + \frac{\partial\vec{A}}{\partial t}\right)\right]$$



Lorentz

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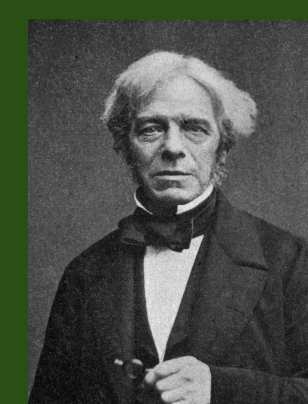


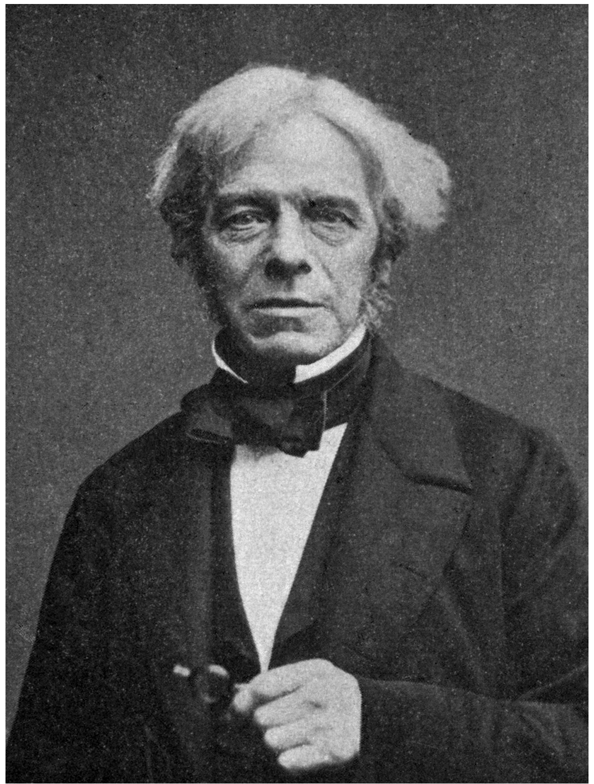
Coulomb

wikipedia

Mais uma equação de Maxwell

$$\vec{E} = -\vec{\nabla} V - \frac{\partial \vec{A}}{\partial t}$$

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



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

Equações de Maxwell

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

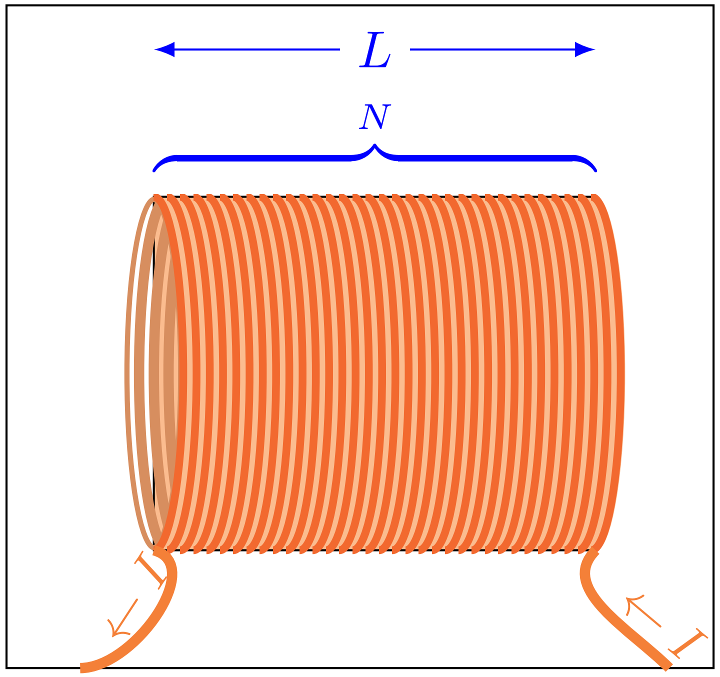
$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

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

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$$

Auto-indução

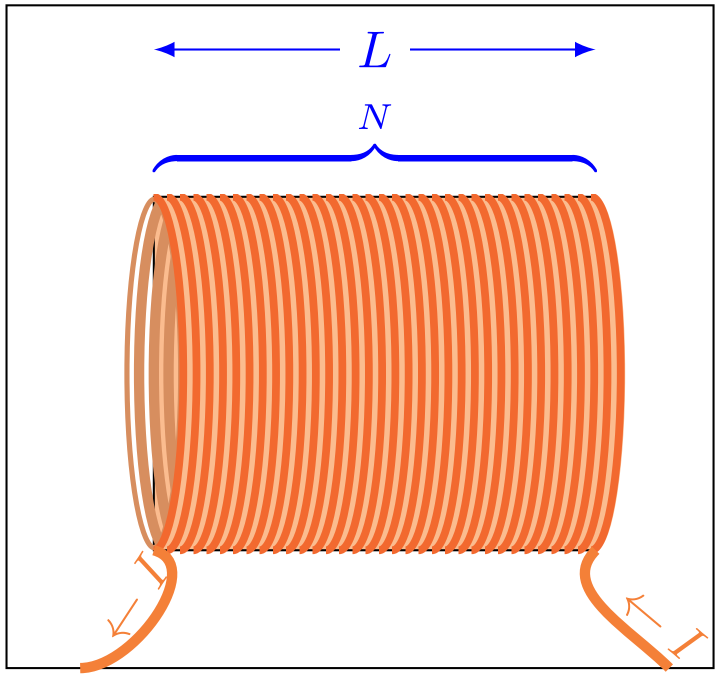
$$B = \mu_0 \frac{N}{L} I$$



Auto-indução

$$B = \mu_0 \frac{N}{L} I$$

$$\Phi = N \mu_0 \frac{N}{L} I \pi r^2$$



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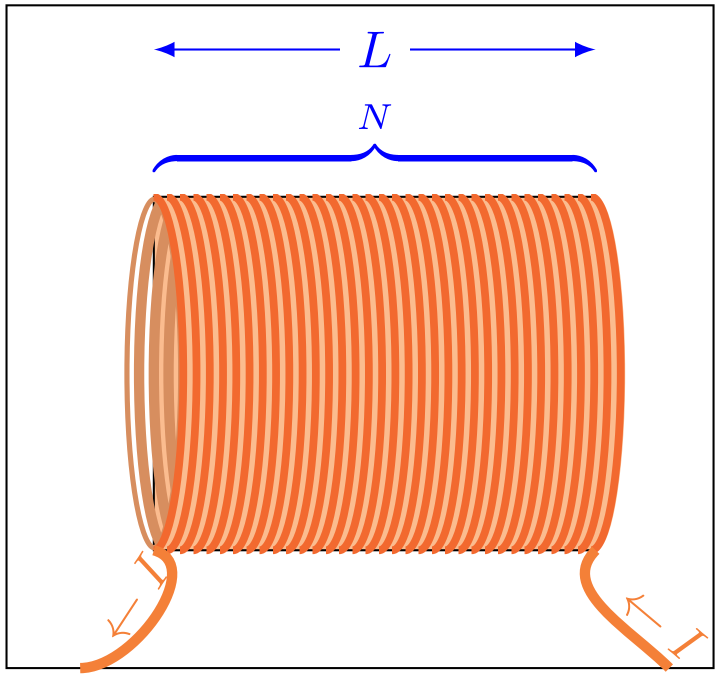
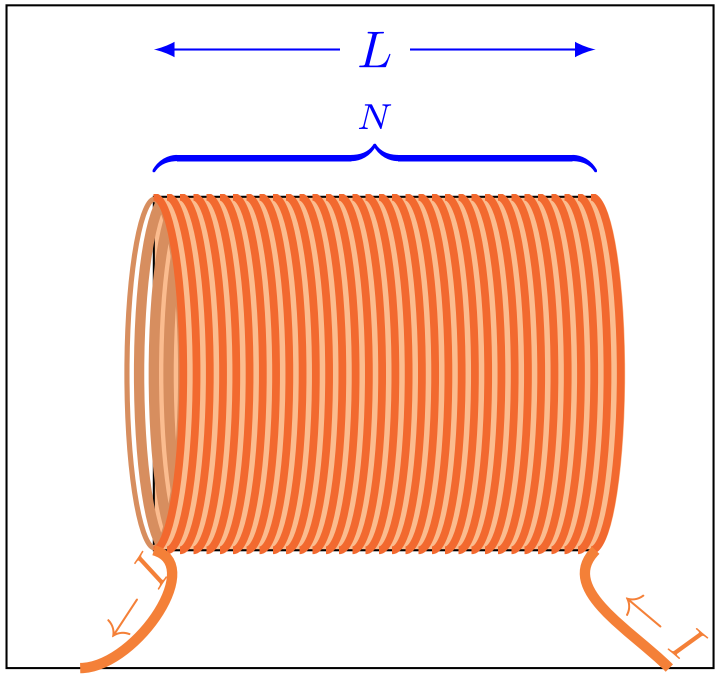


$$\Phi = N \mu_0 \frac{N}{L} I \pi r^2$$

$$\mathscr{E} = -\frac{d\left(\mu_0 \frac{N^2}{L} I \pi r^2\right)}{dt}$$

Auto-indução

$$B = \mu_0 \frac{N}{L} I$$



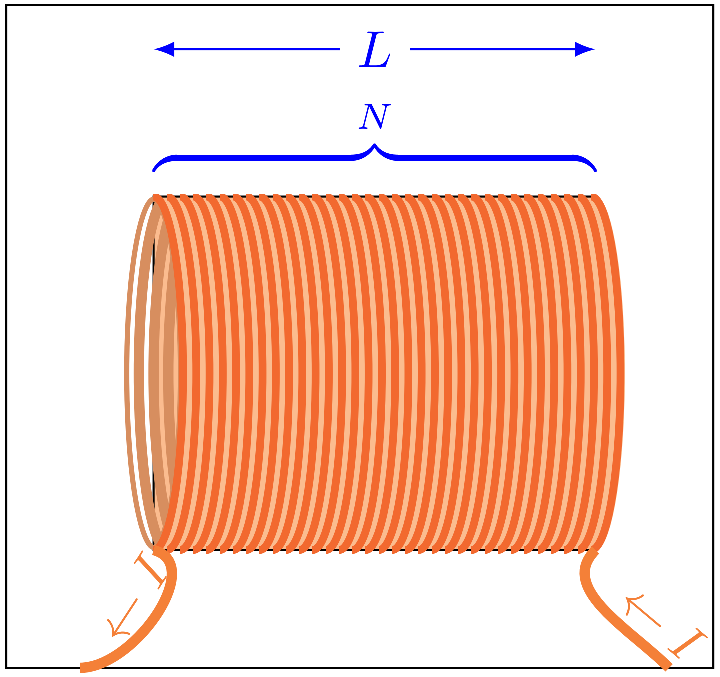
$$\Phi = N\mu_0 \frac{N}{L} I\pi r^2$$

$$\mathcal{E} = -\frac{d\left(\mu_0 \frac{N^2}{L} I\pi r^2\right)}{dt}$$

$$\mathcal{E} = -\mu_0 \frac{N^2}{L} \pi r^2 \frac{dI}{dt}$$

Auto-indução

$$B = \mu_0 \frac{N}{L} I$$



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$$\mathscr{E} = -\frac{d\left(\mu_0 \frac{N^2}{L} I \pi r^2\right)}{dt}$$

$$\mathscr{E} = -\mu_0 \frac{N^2}{L} \pi r^2 \frac{dI}{dt}$$

$$\mathscr{E} = -\mathscr{L} \frac{dI}{dt}$$