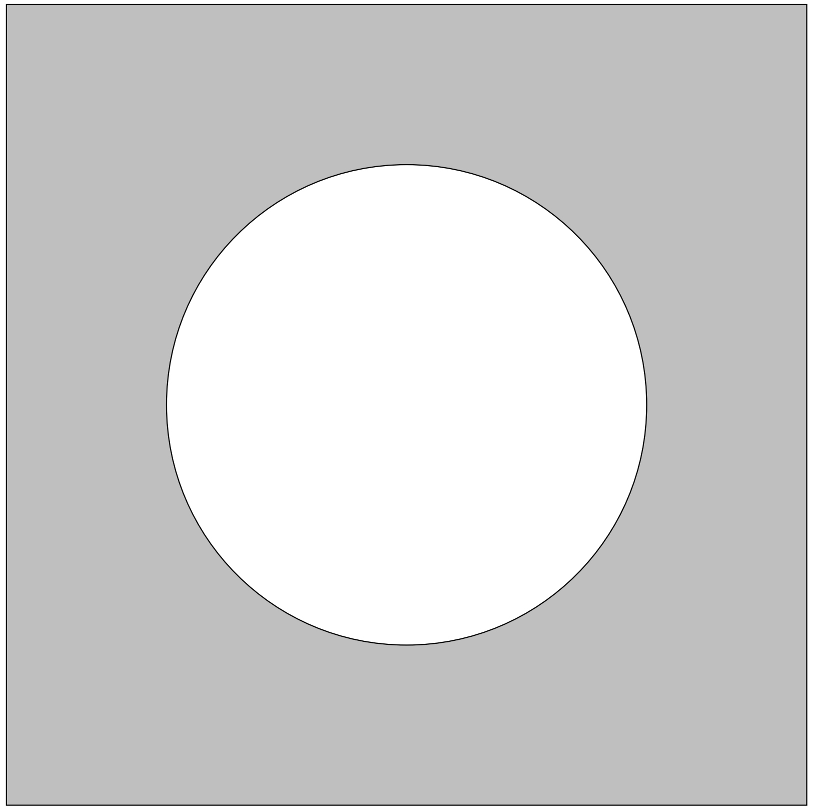
Eletromagnetismo

23 de abril
Eletrostática

Condutores



- No interior do material,

  $$\overrightarrow{E} = 0$$

  $$\rho = 0$$

  Potencial é constante

- No interior de uma cavidade,

  $$\overrightarrow{E} = 0$$

  $$q = 0$$

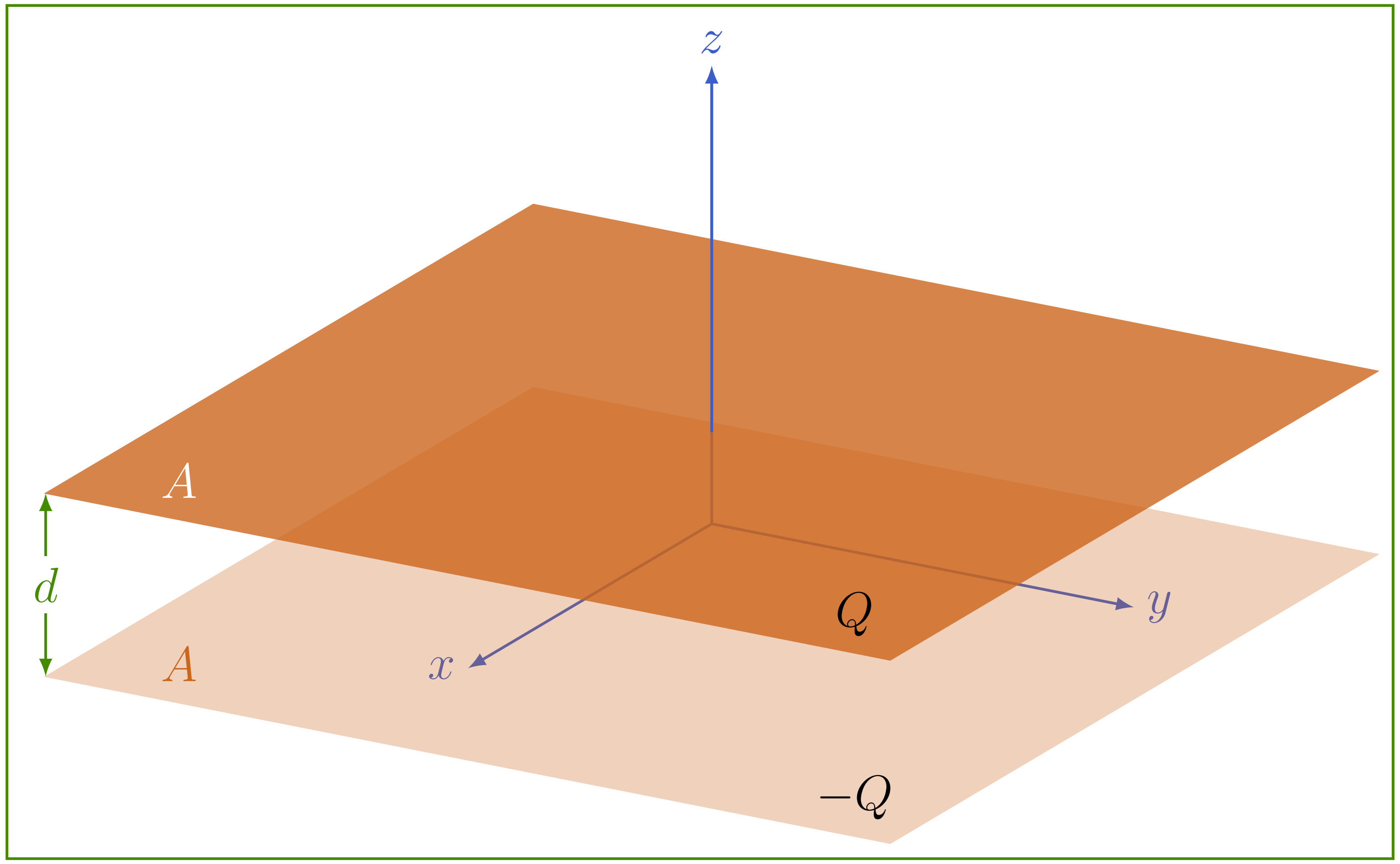
- Perto de uma superfície,

  $$\overrightarrow{E} = \frac{\sigma}{\epsilon_0}\hat{n}$$

Capacitores

- Dois condutores isolados, um do outro
- Cargas de sinais opostos

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



Capacitores

- Dois condutores isolados, um do outro
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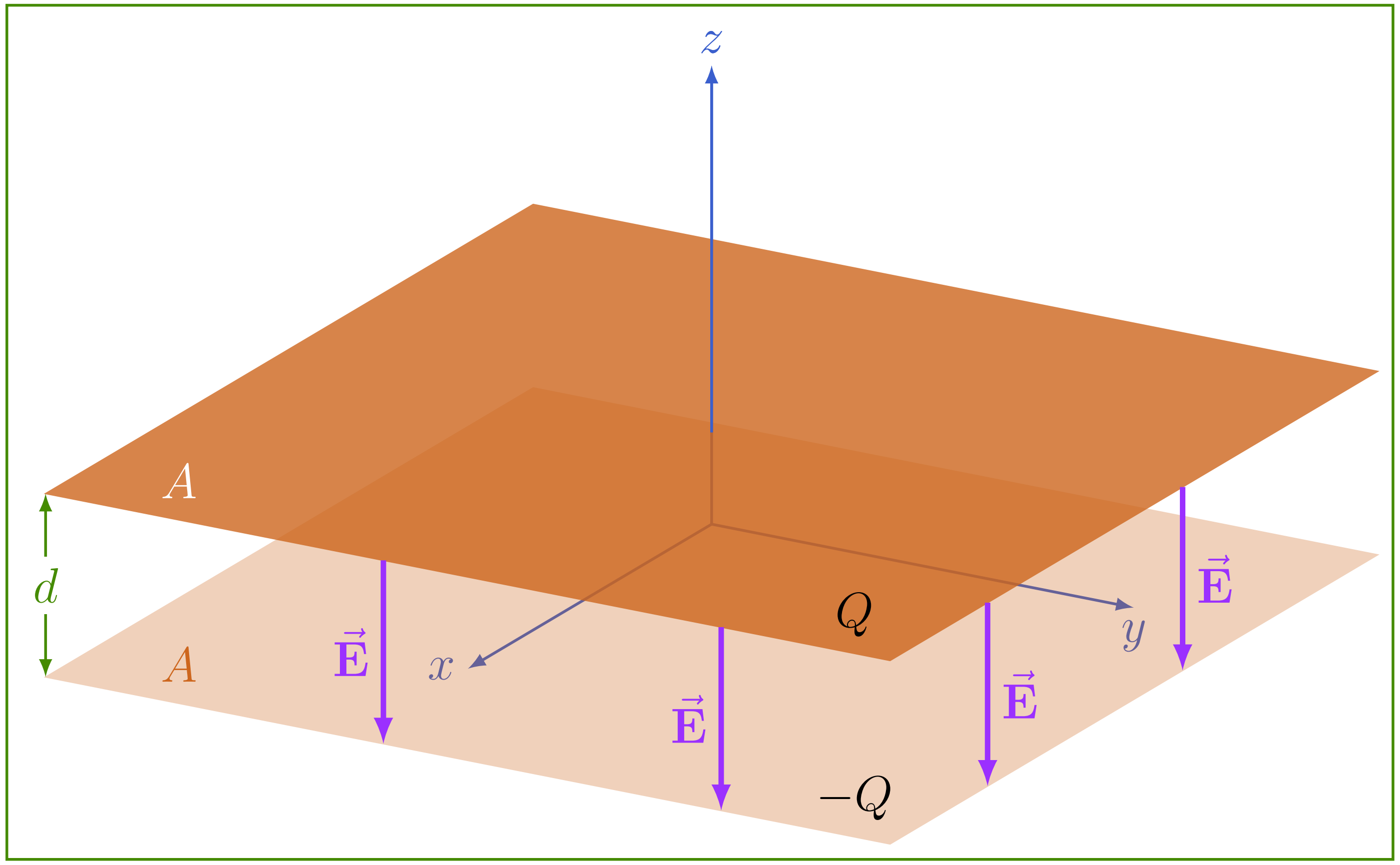
$$C = \frac{Q}{V}$$

$$\vec{\mathbf{E}} = -\frac{\sigma}{\epsilon_0}\hat{\mathbf{z}}$$



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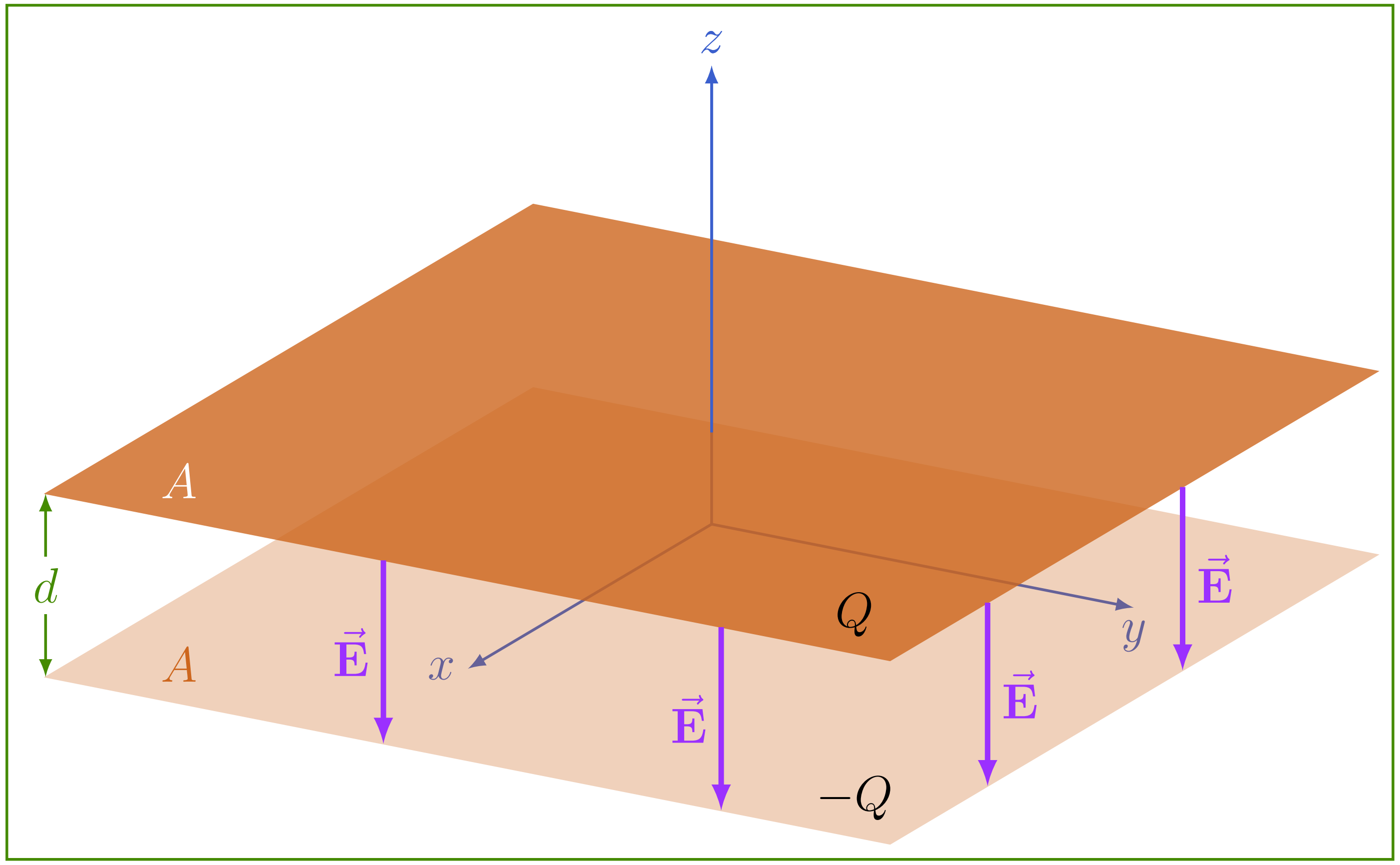
$$\vec{\mathbf{E}} = -\frac{Q}{A\epsilon_0}\hat{\mathbf{z}}$$



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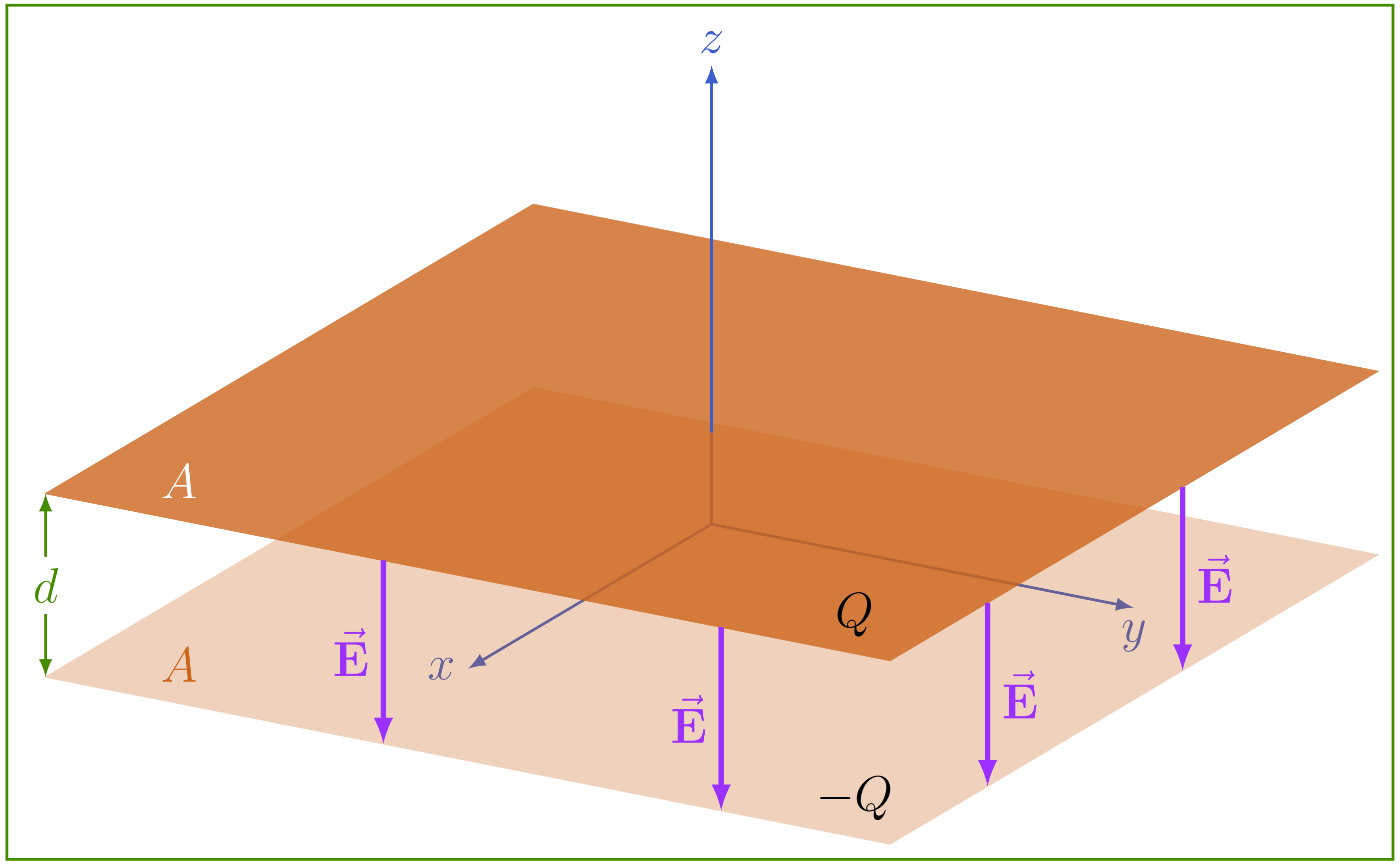
$$V = \frac{Q}{A\epsilon_0}d$$



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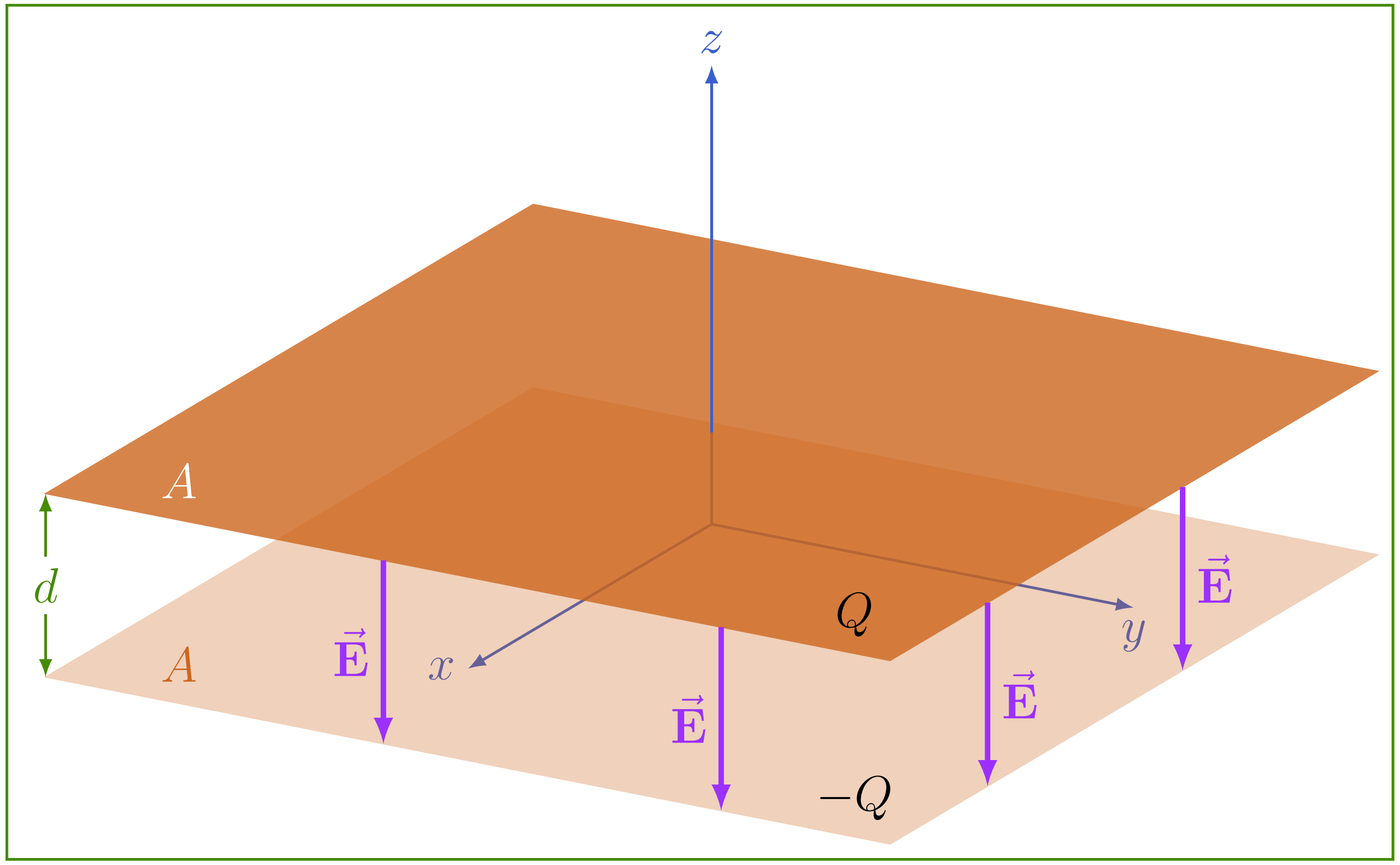


$$\vec{\mathbf{E}} = -\frac{\sigma}{\epsilon_0}\hat{\mathbf{z}}$$

$$\vec{\mathbf{E}} = -\frac{Q}{A\epsilon_0}\hat{\mathbf{z}}$$

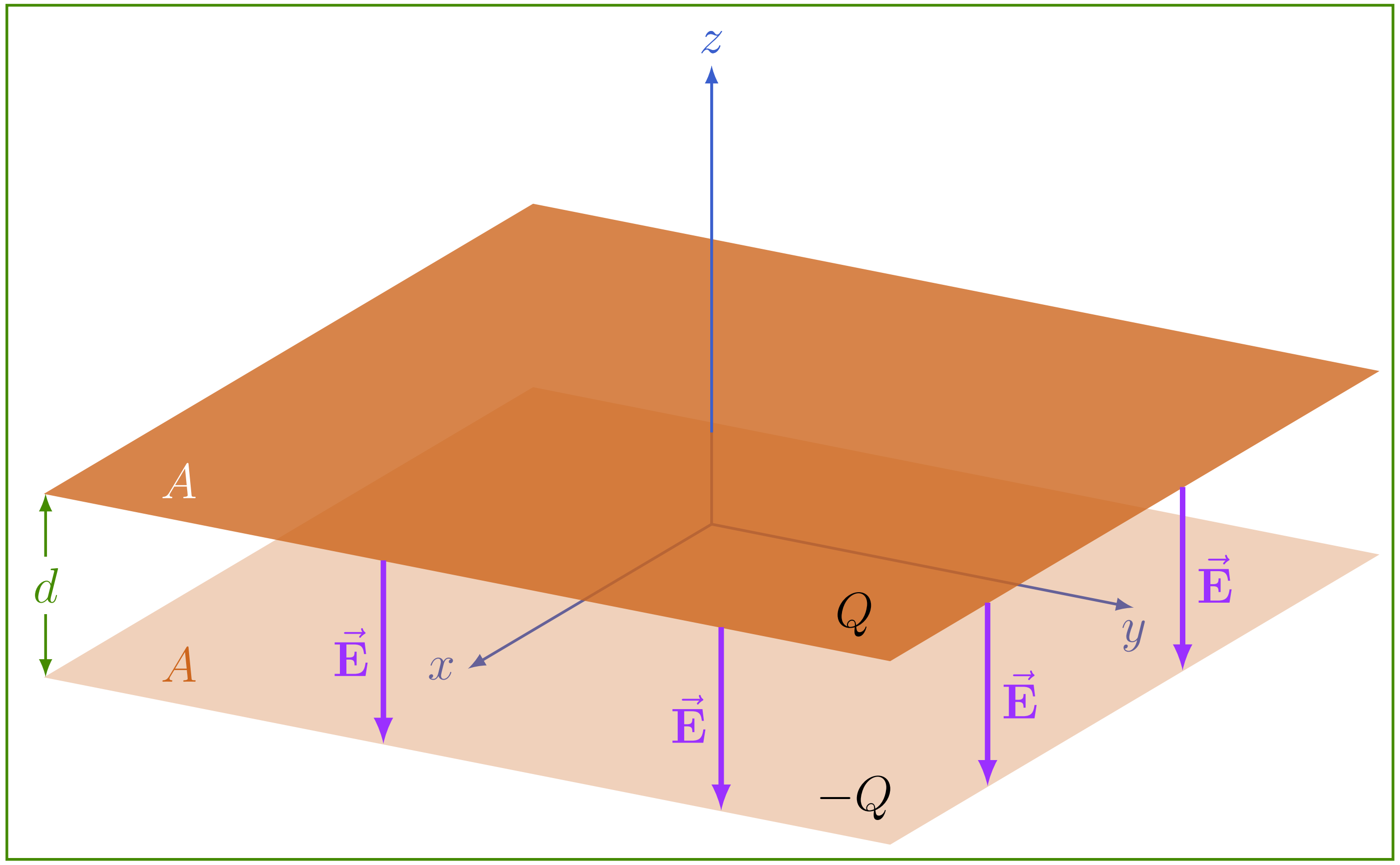
$$V = \frac{Q}{A\epsilon_0}d \quad \Rightarrow \quad C = \frac{A\epsilon_0}{d}$$

Capacitores

$$C = \frac{A\epsilon_0}{d}$$

- Energia?

$$W = \frac{\epsilon_0}{2} \int E^2 \, \mathrm{d}\tau$$



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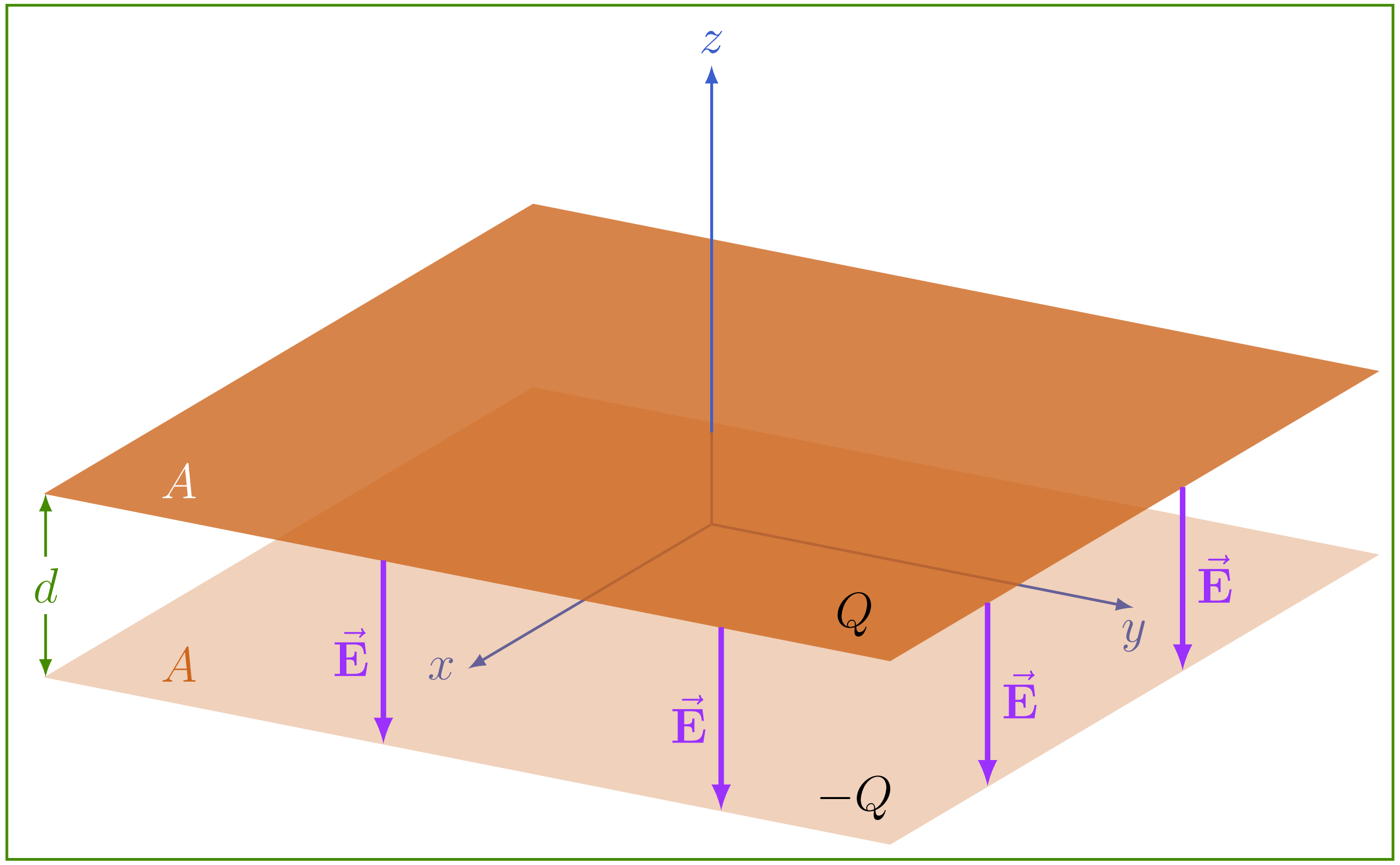
$$W = \frac{\epsilon_0}{2}\left(\frac{Q}{A\epsilon_0}\right)^2 (Ad)$$



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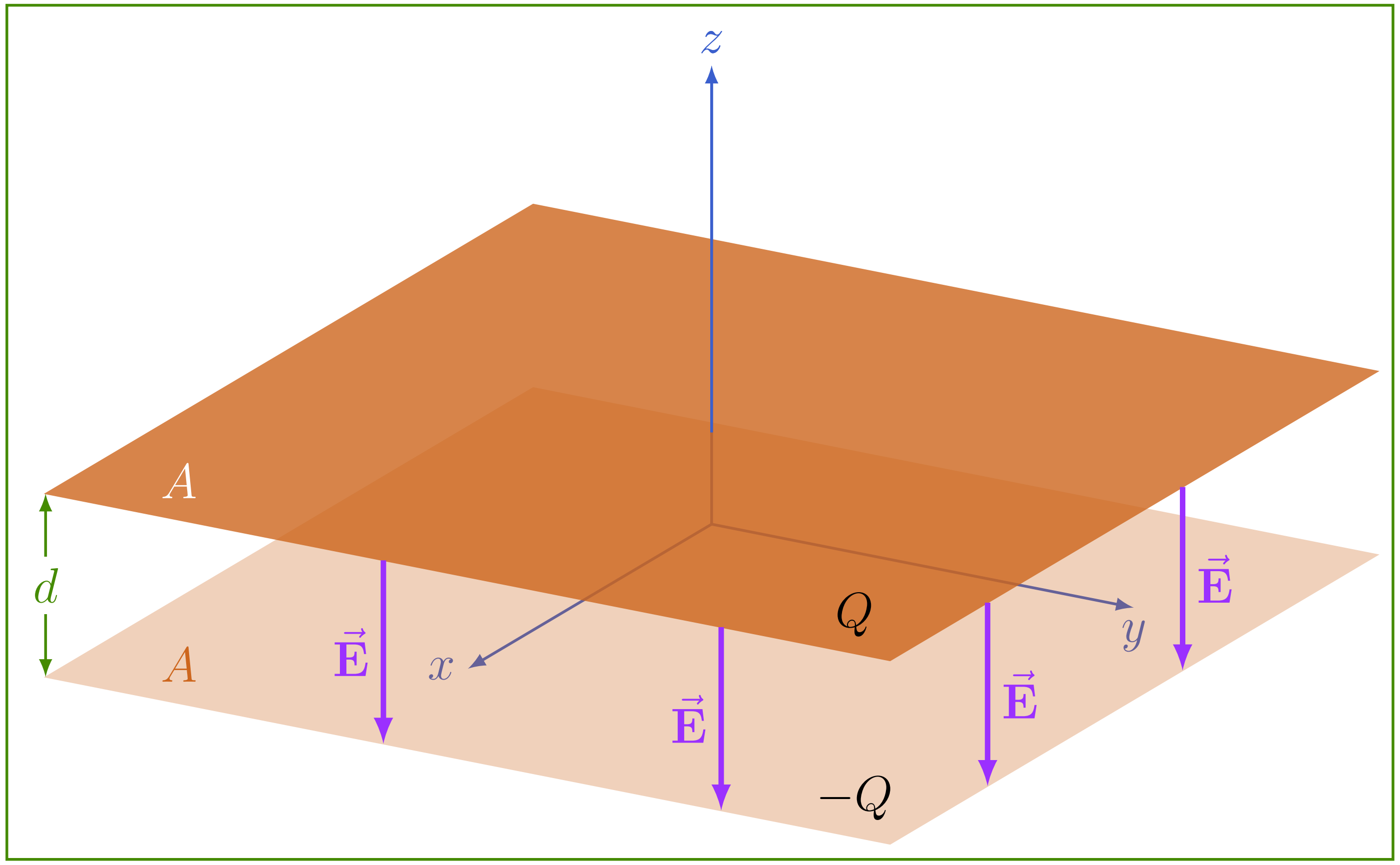
$$W = \frac{Q^2}{2A\epsilon_0} d$$



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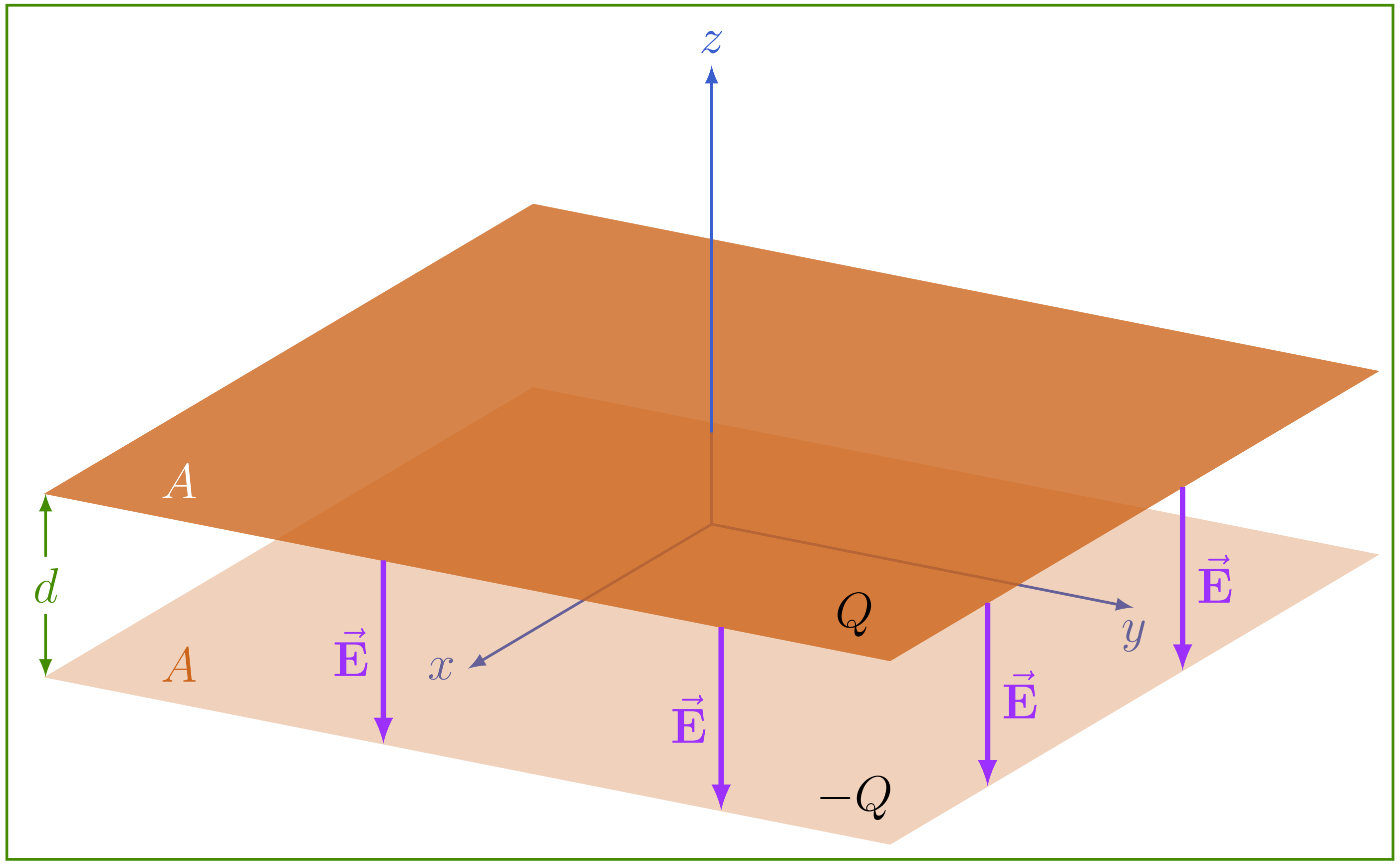
$$W = \frac{Q^2}{2A\epsilon_0}d$$

$$W = \frac{Q^2}{2C}$$



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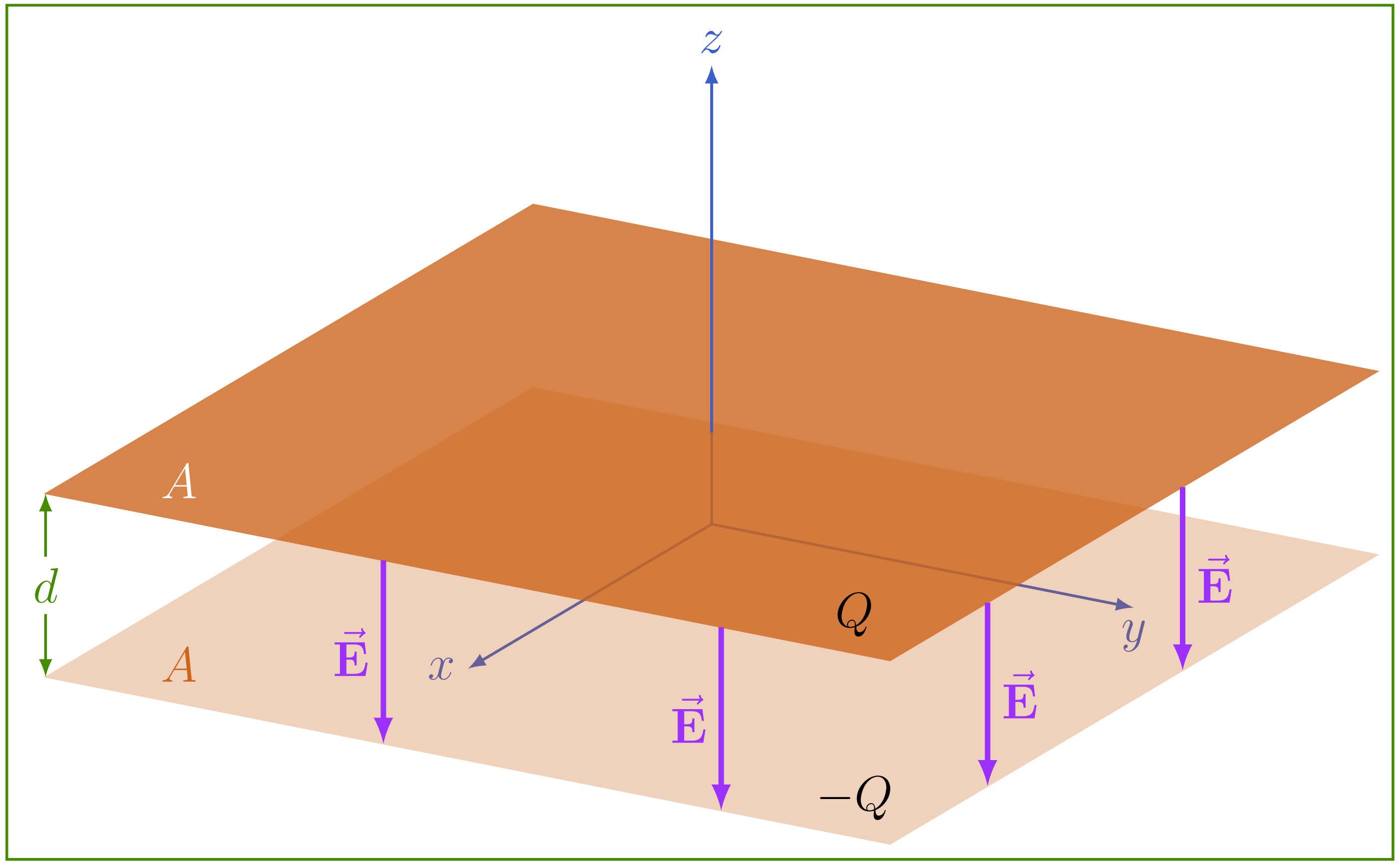


Métodos matemáticos

23 de abril

Equação de Poisson

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

$$\vec{\boldsymbol{\nabla}} \cdot \left(-\vec{\boldsymbol{\nabla}} V\right) = \frac{\rho}{\epsilon_0}$$

Equação de Poisson

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

$$\vec{\boldsymbol{\nabla}} \cdot \left(-\vec{\boldsymbol{\nabla}} V \right) = \frac{\rho}{\epsilon_0}$$

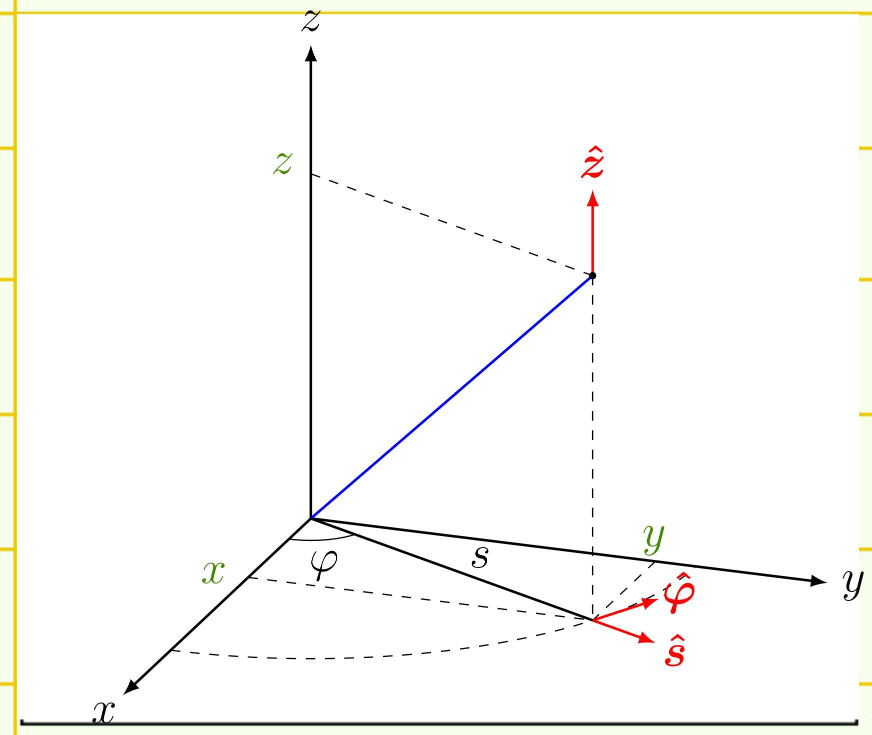
$$\nabla^2 V = -\frac{\rho}{\epsilon_0}$$

Equação de Laplace

$$\boxed{\nabla^2 V = 0}$$

Coordenadas cilíndricas

$$\mathrm{d}\vec{\ell} = \mathrm{d}s\,\hat{s} + s\,\mathrm{d}\phi\,\hat{\phi} + \mathrm{d}z\,\hat{z}$$



$$\vec{\nabla} T = \frac{\partial T}{\partial s}\hat{s} + \frac{1}{s}\frac{\partial T}{\partial \phi}\hat{\phi} + \frac{\partial T}{\partial z}\hat{z}$$

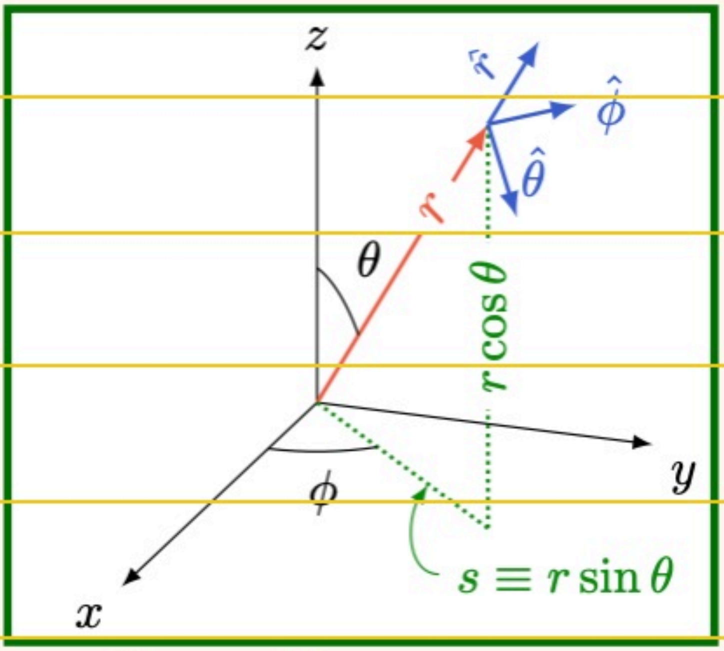
$$\vec{\nabla} \cdot \vec{v} = \frac{1}{s}\frac{\partial (s v_s)}{\partial s} + \frac{1}{s}\frac{\partial v_\phi}{\partial \phi} + \frac{\partial v_z}{\partial z}$$

$$\vec{\nabla} \times \vec{v} = \left(\frac{1}{s}\frac{\partial v_z}{\partial \phi} - \frac{\partial v_\phi}{\partial z}\right)\hat{s} + \left(\frac{\partial v_s}{\partial z} - \frac{\partial v_z}{\partial s}\right)\hat{\phi} + \frac{1}{s}\left(\frac{\partial (s v_\phi)}{\partial s} - \frac{\partial v_s}{\partial \phi}\right)\hat{z}$$

$$\nabla^2 T = \frac{1}{s}\frac{\partial}{\partial s}\left(s\frac{\partial T}{\partial s}\right) + \frac{1}{s^2}\frac{\partial^2 T}{\partial \phi^2} + \frac{\partial^2 T}{\partial z^2}$$

Coordenadas esféricas

$$d\vec{\ell} = dr\,\hat{r} + r\,d\theta\,\hat{\theta} + r\sin\theta\,d\phi\,\hat{\phi}$$



$$\vec{\nabla} t = \frac{\partial t}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial t}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial t}{\partial \phi}\hat{\phi}$$

$$\vec{\nabla}\cdot\vec{v} = \frac{1}{r^2}\frac{\partial(r^2 v_r)}{\partial r} + \frac{1}{r\sin\theta}\frac{\partial(\sin\theta v_\theta)}{\partial\theta} + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial\phi}$$

$$\vec{\nabla}\times\vec{v} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}\left(\sin\theta v_\phi\right) - \frac{\partial v_\theta}{\partial\phi}\right]\hat{r} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial v_r}{\partial\phi} - \frac{\partial}{\partial r}\left(r v_\phi\right)\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial}{\partial r}\left(r\,v_\theta\right) - \frac{\partial v_r}{\partial\theta}\right]\hat{\phi}$$

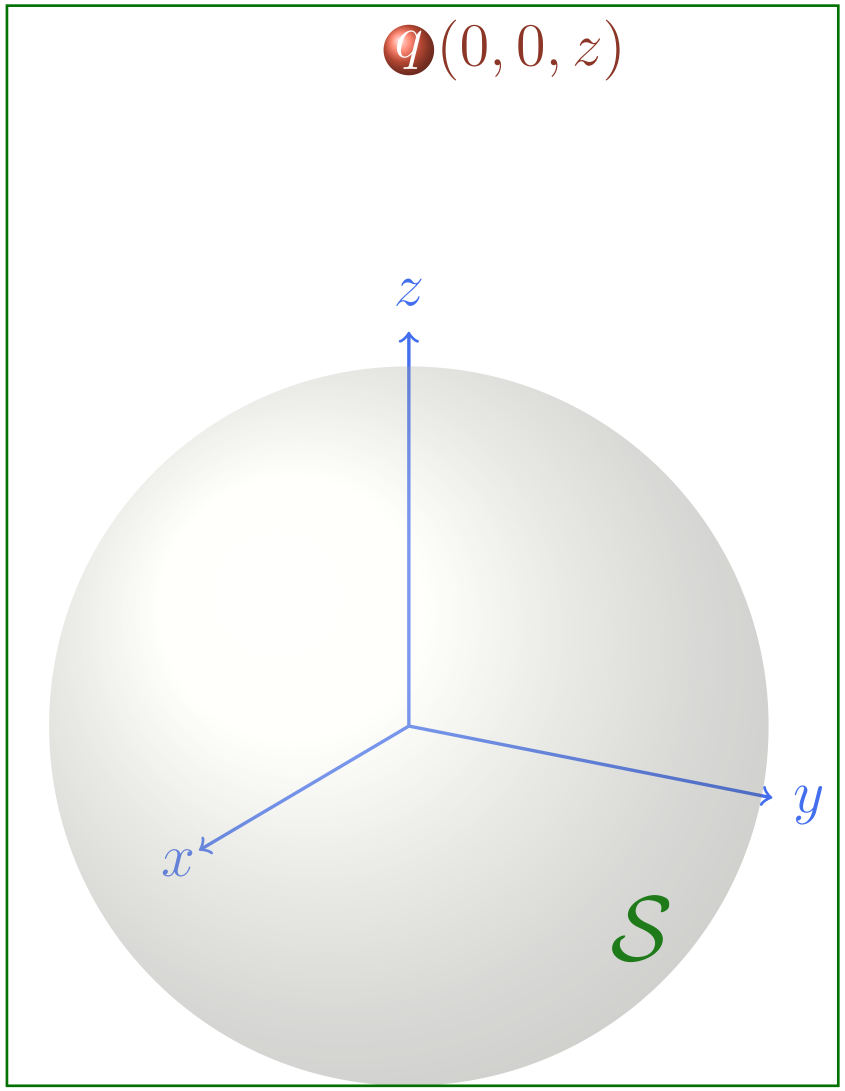
$$\nabla^2 t = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial t}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial t}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 t}{\partial\phi^2}$$

Equação de Laplace

$$\boxed{\nabla^2 V = 0}$$

- Propriedades

$$\frac{1}{4\pi R^2}\int_S V(\vec{\mathbf{r}'})\,\mathrm{d}A' = V(0)$$



Equação de Laplace

$$\boxed{\nabla^2 V = 0}$$

- Propriedades

$$\frac{1}{4\pi R^2}\int_S V(\vec{\mathbf{r}}')\,\mathrm{d}A' = V(0)$$

$\Rightarrow$ • $V(\vec{r})$ não possui extremos