Eletromagnetismo

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

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

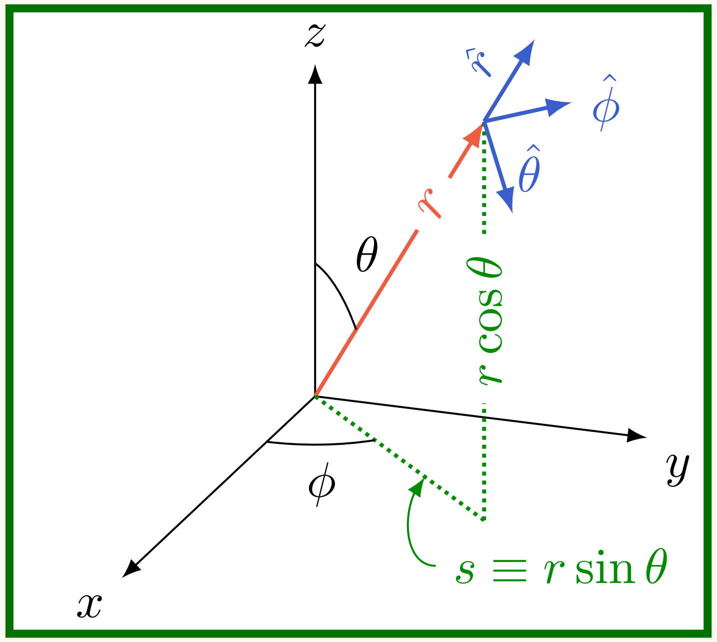
$$\vec{\nabla} \cdot \vec{B} = 0$$

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

Aula de 17 de maio
Eletrostática

Coordenadas esféricas

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



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

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

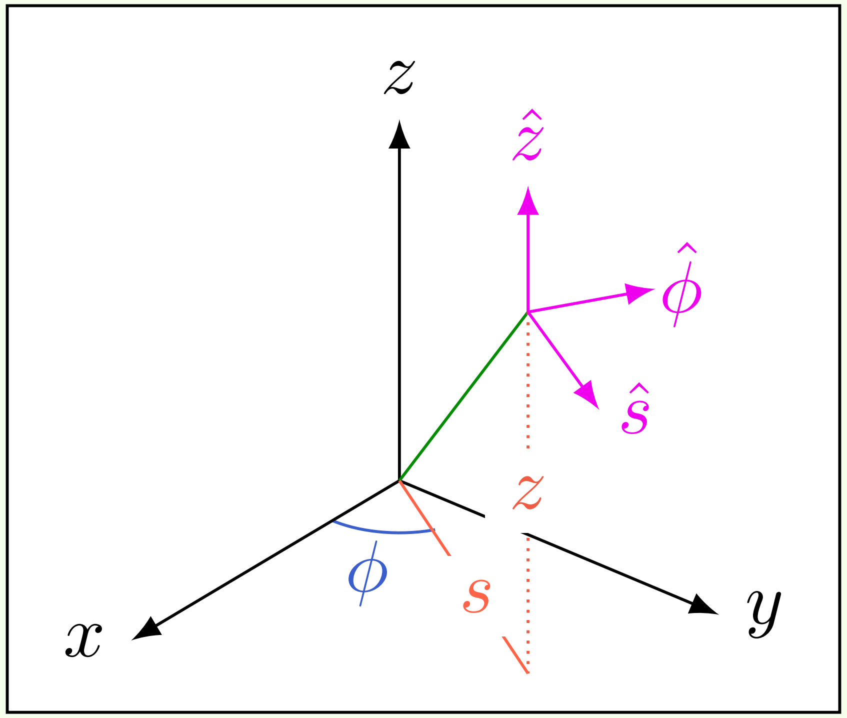
$$\vec{\nabla}\times\vec{v} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}\left(\sin\theta v_\phi\right) - \frac{\partial v_\theta}{\partial\phi}\right]\hat{r}$$

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

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

Coordenadas cilíndricas

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



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

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

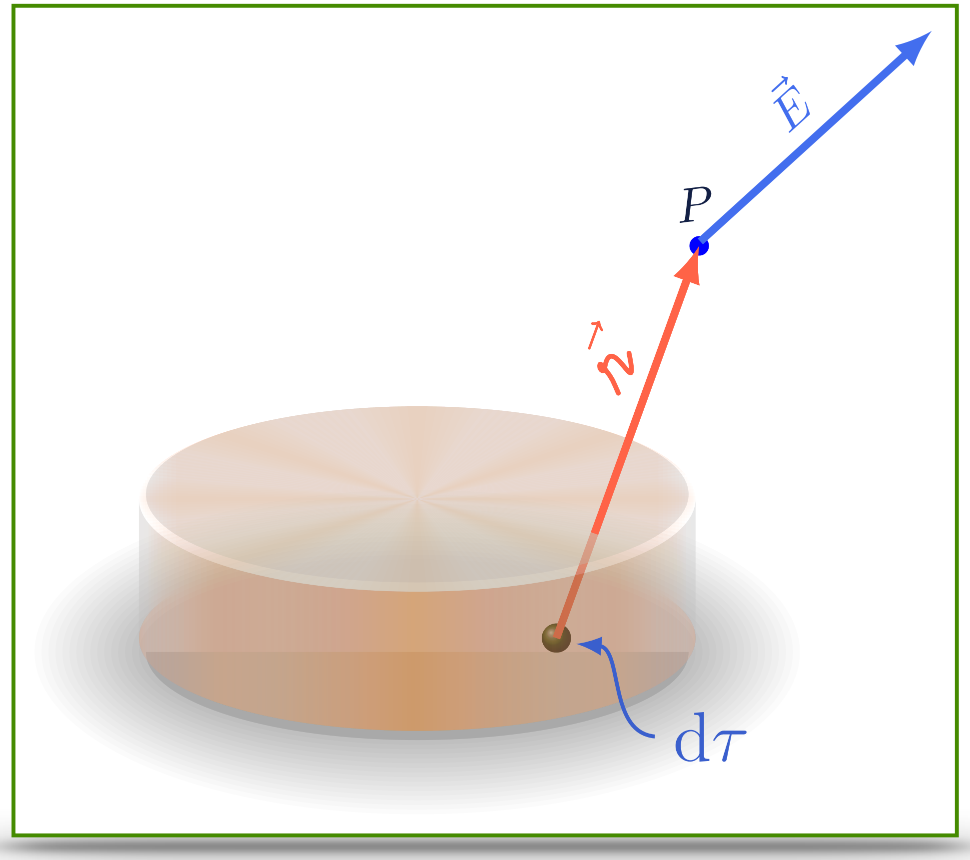
$$\vec{\boldsymbol{\nabla}} \times \vec{v} = \left(\frac{1}{s}\frac{\partial v_z}{\partial \phi} - \frac{\partial v_\phi}{\partial z}\right)\hat{s} + \left(\frac{\partial v_s}{\partial z} - \frac{\partial v_z}{\partial s}\right)\hat{\phi} + \frac{1}{s}\left(\frac{\partial (s v_\phi)}{\partial s} - \frac{\partial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

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

Eletrostática

Campo de distribuição de cargas

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\int \frac{1}{\mathscr{r}^2}\hat{\mathscr{r}}\,\mathrm{d}q$$



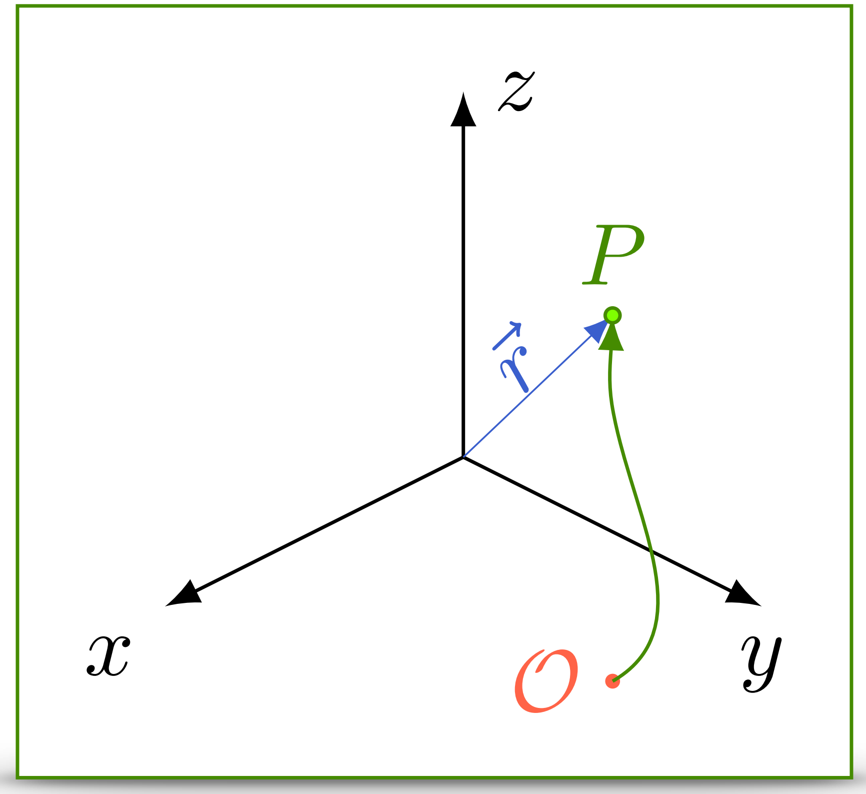
$$\vec{\nabla} \times \vec{E} = 0$$

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

Potencial elétrico

$$\vec{\nabla} \times \vec{E} = 0$$

$$V(P) = -\int_{\mathcal{O}}^{\vec{r}} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

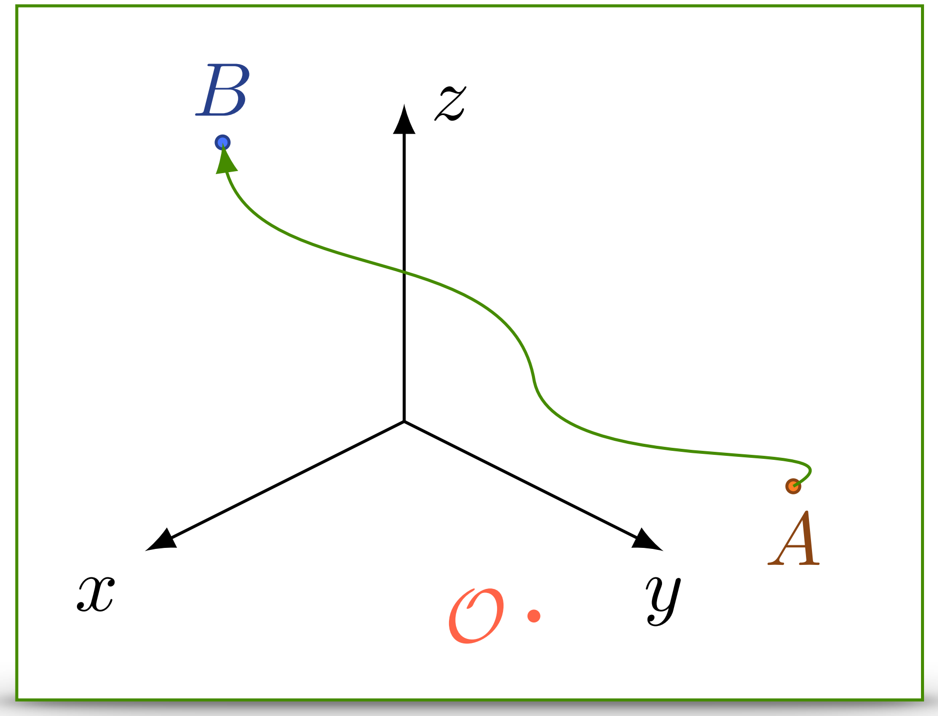


Diferença de potencial

$$\vec{\boldsymbol{\nabla}} \times \vec{E} = 0$$

$$\Delta V = -\int_{\vec{r}_a}^{\vec{r}_b} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

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



Potencial de uma carga

$$V(P) = \int_P^{\mathcal{O}} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

Referência no infinito

$$V(\vec{r}) = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

Rotacional do campo

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$

$$\int_{\vec{a}}^{\vec{b}} \vec{E}(\vec{r}) \cdot \mathrm{d}\vec{\ell} = \frac{1}{4\pi\epsilon_0} \int_{\vec{a}}^{\vec{b}} \frac{q}{r^2} \hat{r} \cdot \mathrm{d}\vec{\ell}$$

$$\int_{\vec{a}}^{\vec{b}} \vec{E}(\vec{r}) \cdot \mathrm{d}\vec{\ell} = \frac{1}{4\pi\epsilon_0} \int_{r_a}^{r_b} \frac{q}{r^2} \mathrm{d}r$$

$$\int_{\vec{a}}^{\vec{b}} \vec{E}(\vec{r}) \cdot \mathrm{d}\vec{\ell} = \frac{1}{4\pi\epsilon_0} \left(\frac{q}{r_a} - \frac{q}{r_b} \right)$$

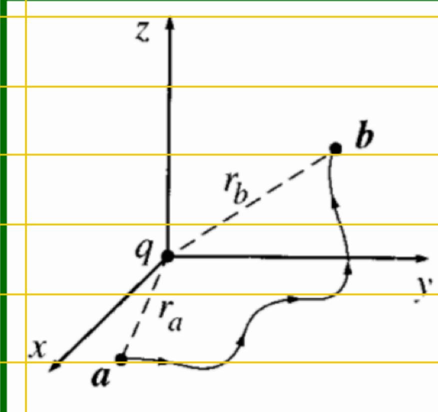
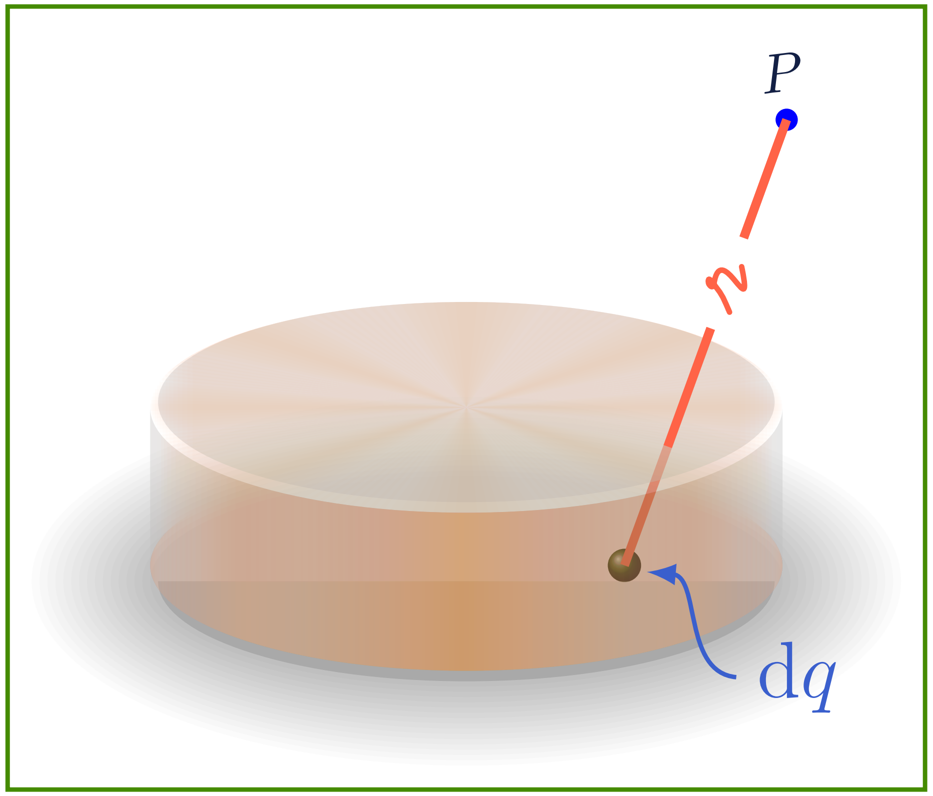


Figure 2.29

Potencial de distribuição de cargas

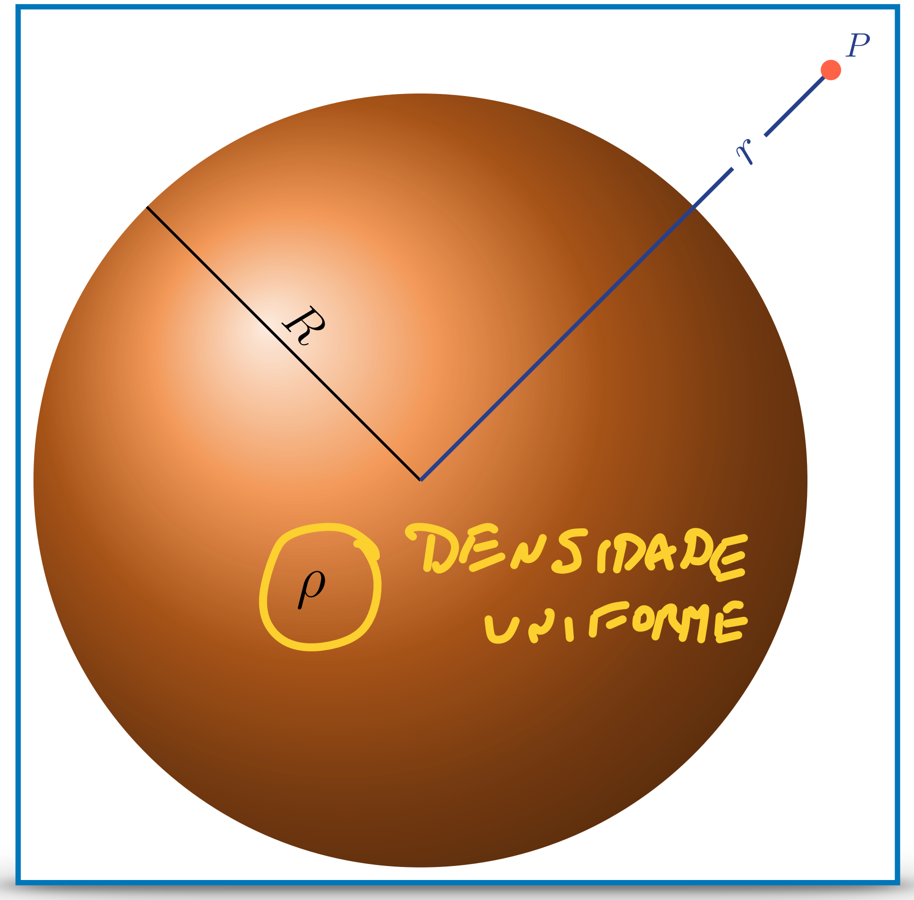
$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

Pratique o que aprendeu

Exercício 9 da segunda lista



Pratique o que aprendeu

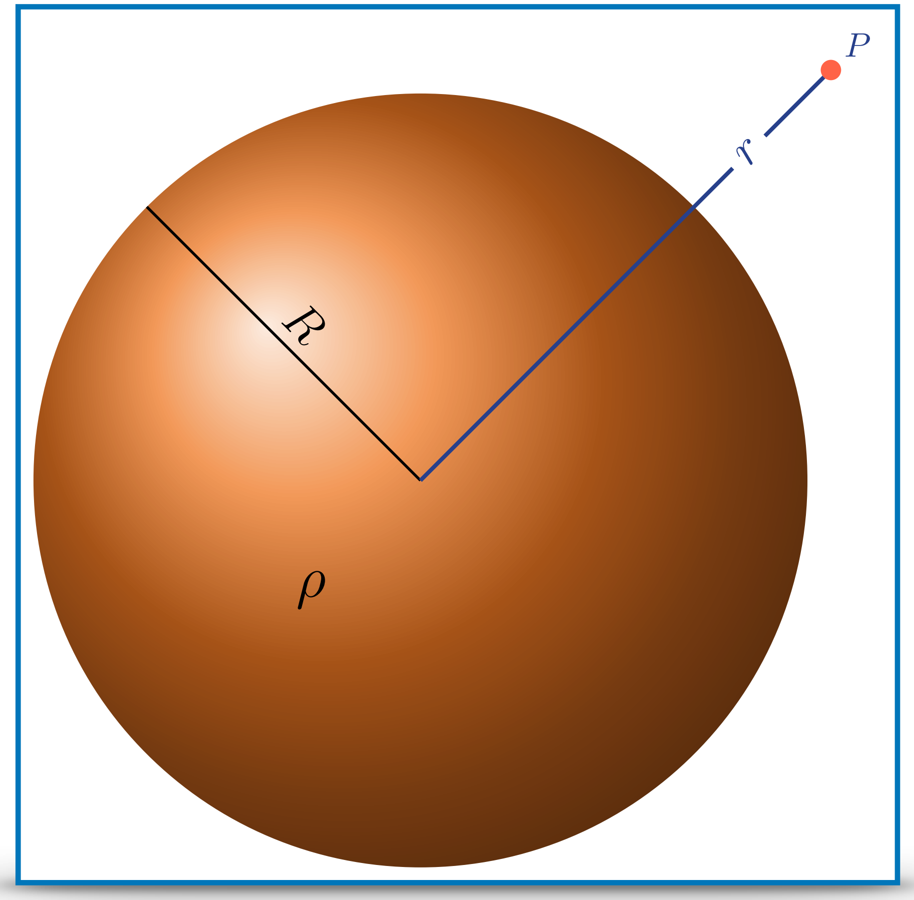
$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot d\vec{\ell}$$

$r > R$

$$V(r) = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$

↳ CAMPO ELÉTRICO FORA DA ESFERA EQUIVALE AO DE UMA CARGA PONTUAL q NO CENTRO DA ESFERA

– POTENCIAL TAMBÉM EQUIVALE AO DE UMA CARGA PONTUAL



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

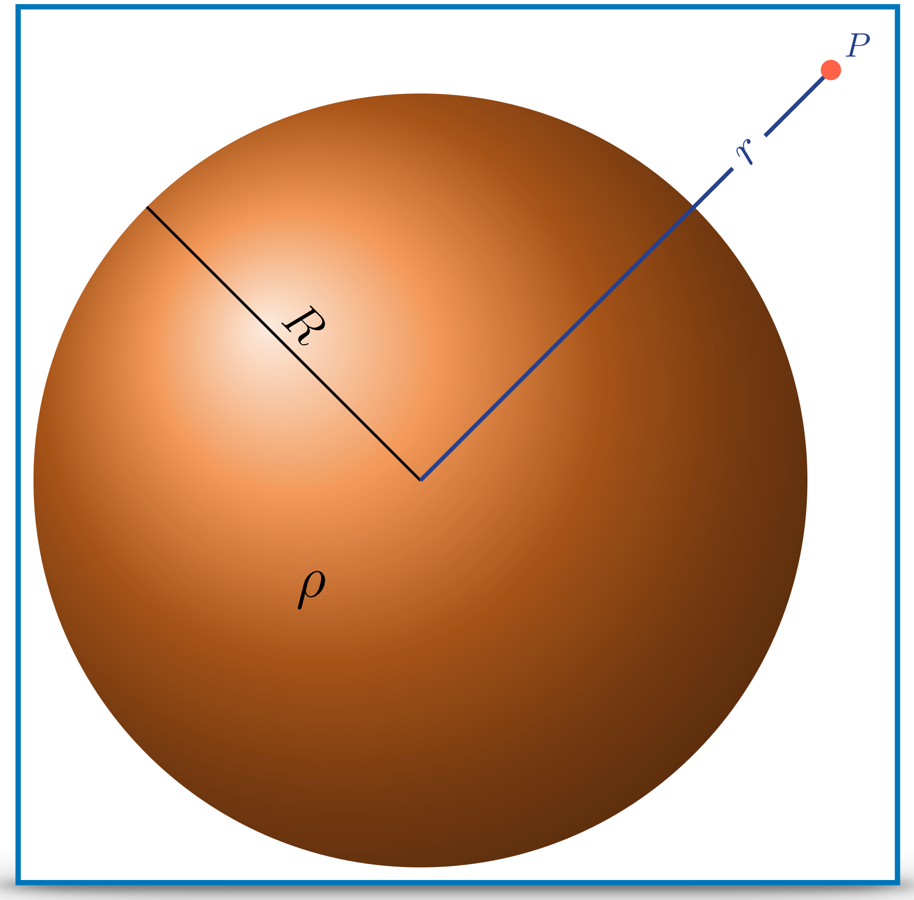
Pratique o que aprendeu

$r > R$

$$V(r) = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$

$$q = \frac{4\pi R^3}{3}\rho$$

VOLUME DA ESFERA



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

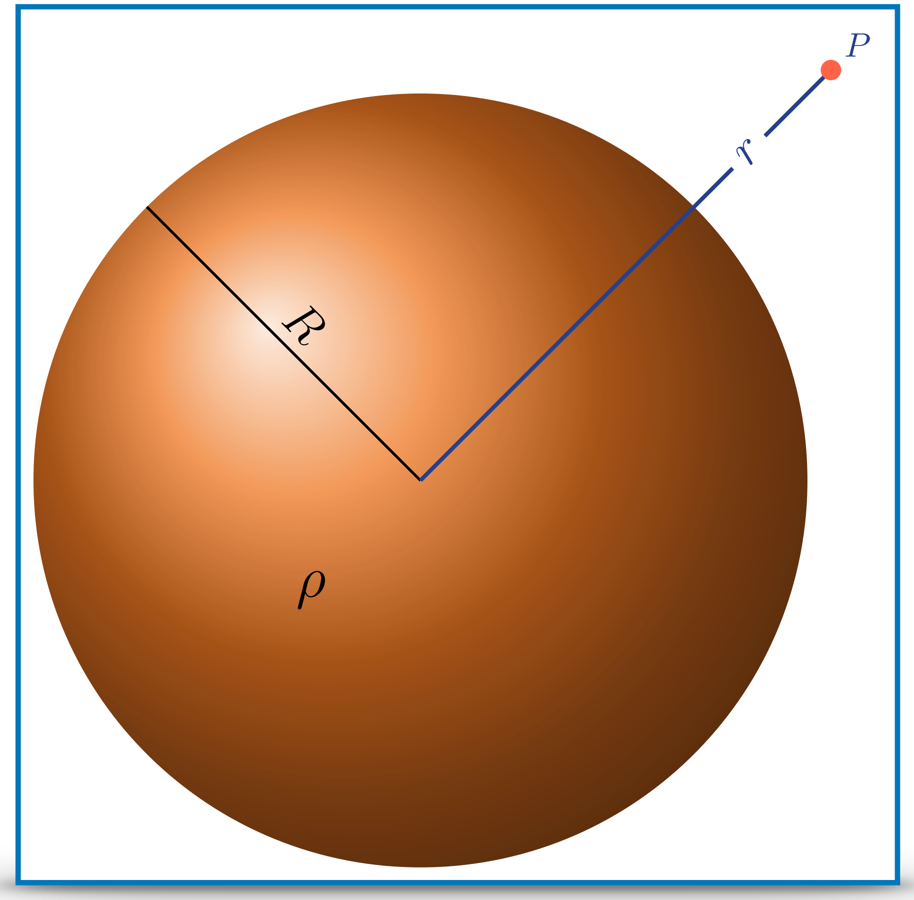
Pratique o que aprendeu

$r > R$

$$V(r) = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$

$$q = \frac{4\pi R^3}{3}\rho$$

$$V(r) = \frac{R^3}{3\epsilon_0}\frac{\rho}{r}$$



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

Pratique o que aprendeu

$$r = R$$

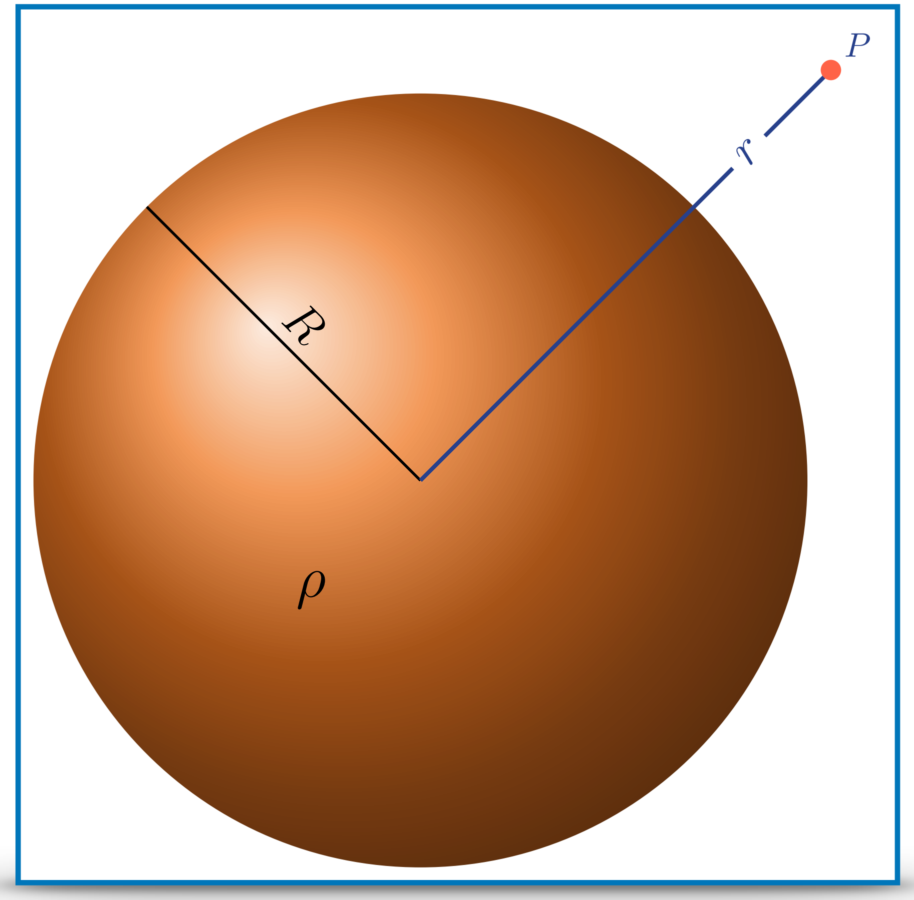
$$V(r) = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

$$q = \frac{4\pi R^3}{3} \rho$$

$$V(r) = \frac{R^3}{3\epsilon_0} \frac{\rho}{r}$$

$$V(r = R) = \frac{R^2}{3\epsilon_0} \rho$$

ÚTIL PARA CALCULAR $V(r < R)$



Pratique o que aprendeu

$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

$r < R$

SUPERFÍCIE ($r=R$)

$$V(r = R) = \frac{R^2}{3\epsilon_0}\rho$$

Pratique o que aprendeu

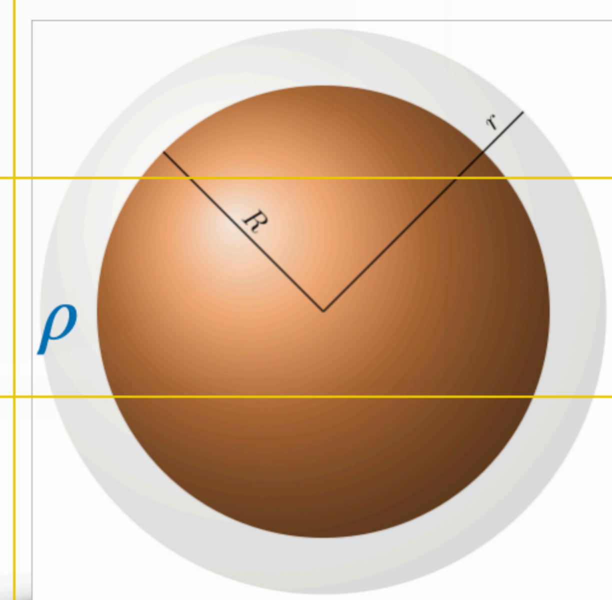
$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

$$\frac{1}{r^2}\frac{\mathrm{d}}{\mathrm{d}r}\left(r^2 E(r)\right) = \frac{\rho}{\epsilon_0}$$

$$\frac{\mathrm{d}}{\mathrm{d}r}\left(r^2 E(r)\right) = \frac{\rho}{\epsilon_0} r^2$$

$$E(r) - E(0) = \frac{\rho}{\epsilon_0 r^2}\int_0^r r'^2 \, \mathrm{d}r'$$

$$\Rightarrow E(r) = \frac{\rho}{\epsilon_0}\frac{r}{3}$$



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

Pratique o que aprendeu

$r < R$

$$V(r = R) = \frac{R^2}{3\epsilon_0}\rho$$

$$E(r) = \frac{\rho}{3\epsilon_0} r$$

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

Pratique o que aprendeu

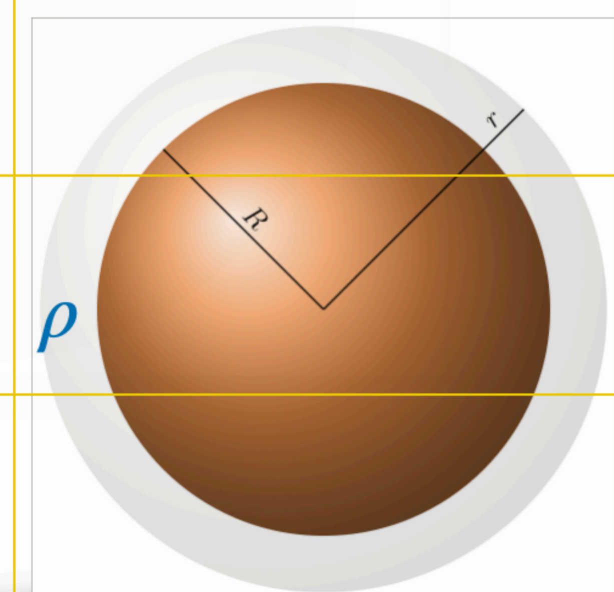
TEVAS DE 10/5

$$\frac{1}{r^2}\frac{\mathrm{d}}{\mathrm{d}r}\left(r^2 E(r)\right) = \frac{\rho}{\epsilon_0}$$

$$\frac{\mathrm{d}}{\mathrm{d}r}\left(r^2 E(r)\right) = \frac{\rho}{\epsilon_0} r^2$$

$$E(r) - E(0) = \frac{\rho}{\epsilon_0 r^2}\int_0^r r'^2 \, \mathrm{d}r'$$

$$\Rightarrow E(r) = \frac{\rho}{\epsilon_0}\frac{r}{3}$$



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

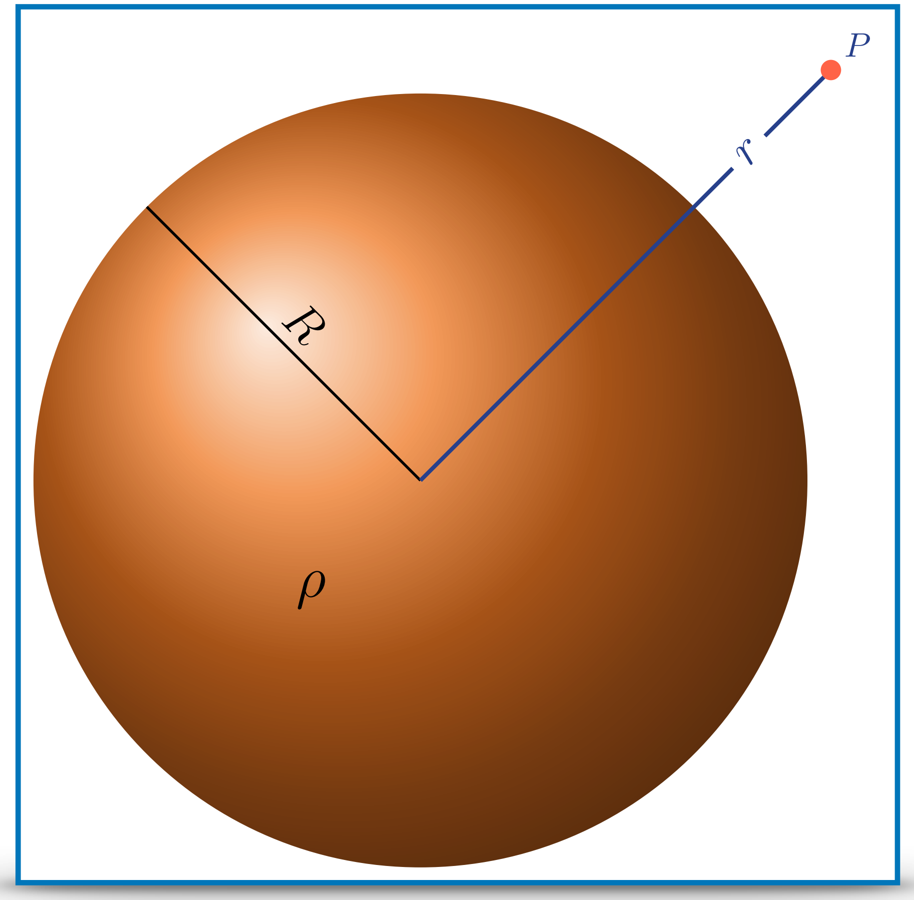
Pratique o que aprendeu

$r < R$

$$V(r = R) = \frac{R^2}{3\epsilon_0}\rho$$

$$E(r) = \frac{\rho}{3\epsilon_0} r$$

$$V(r) - V(R) = \int_r^R E(r')\,\mathrm{d}r'$$



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot \mathrm{d}\vec{\ell}$$

Pratique o que aprendeu

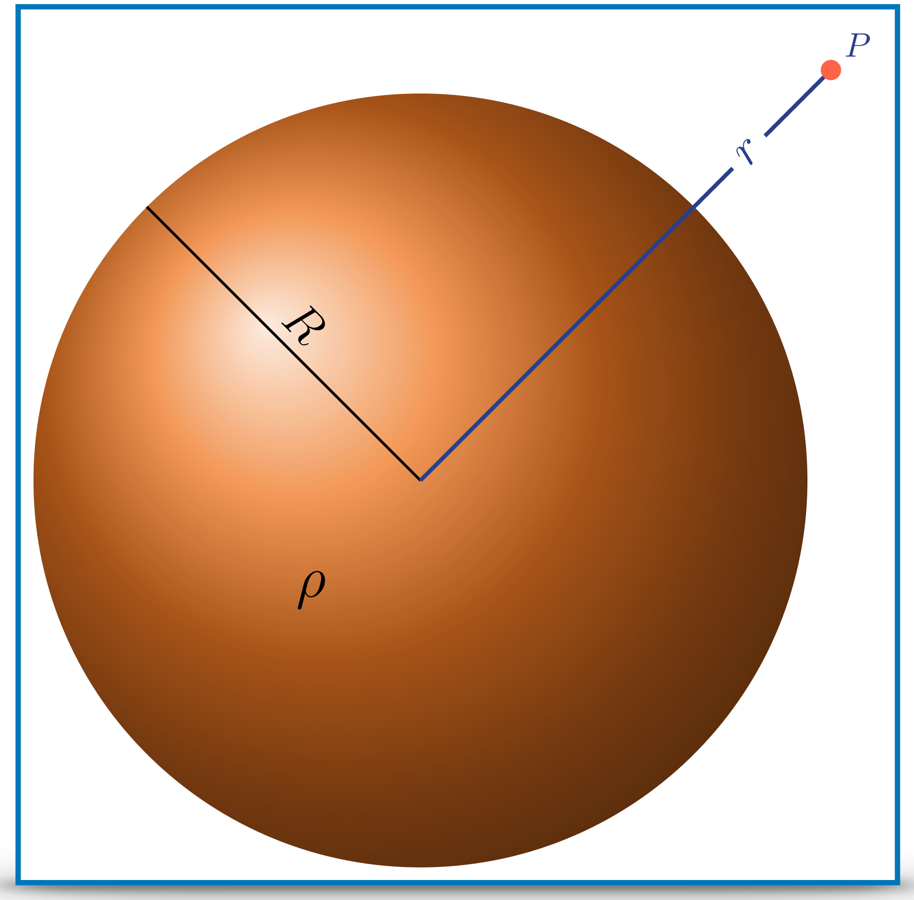
$r < R$

$$V(r = R) = \frac{R^2}{3\epsilon_0}\rho$$

$$E(r) = \frac{\rho}{3\epsilon_0} r$$

$$V(r) - V(R) = \int_r^R E(r')\,\mathrm{d}r'$$

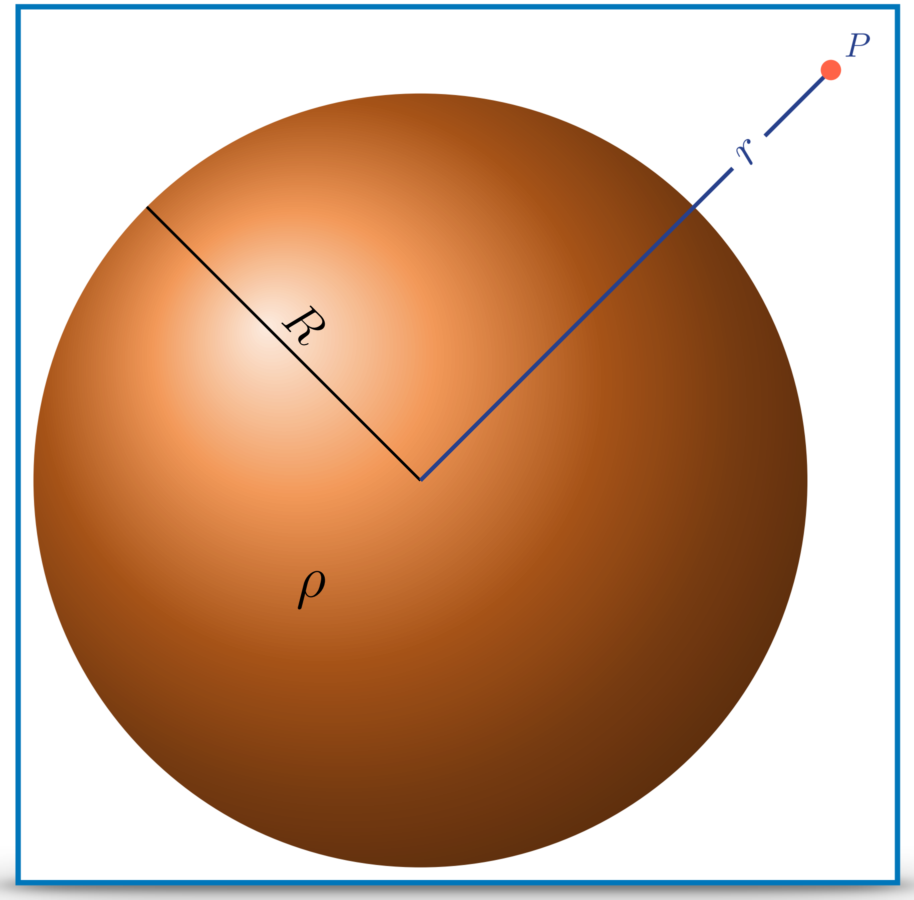
$$V(r) - V(R) = \frac{\rho}{6\epsilon_0}(R^2 - r^2)$$



$$\Delta V = \int_{\vec{r}_b}^{\vec{r}_a} \vec{E} \cdot d\vec{\ell}$$

Pratique o que aprendeu

$r < R$



$$V(r = R) = \frac{R^2}{3\epsilon_0}\rho$$

$$E(r) = \frac{\rho}{3\epsilon_0} r$$

$$V(r) - V(R) = \int_r^R E(r')\, dr'$$

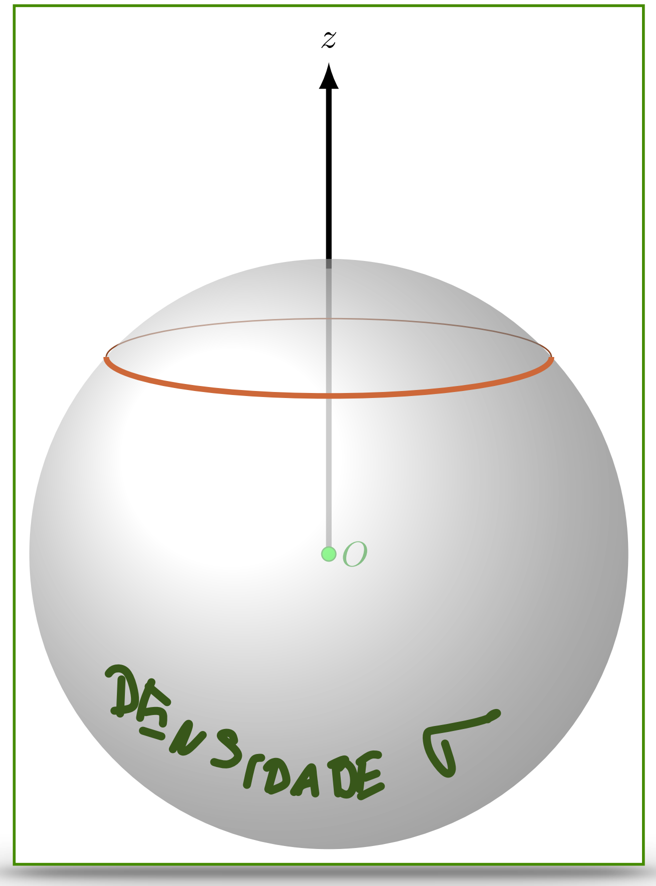
$$V(r) - V(R) = \frac{\rho}{6\epsilon_0}(R^2 - r^2)$$

$$\Rightarrow V(r) = \frac{\rho}{2\epsilon_0}\left(R^2 - \frac{r^2}{3}\right)$$

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{r}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

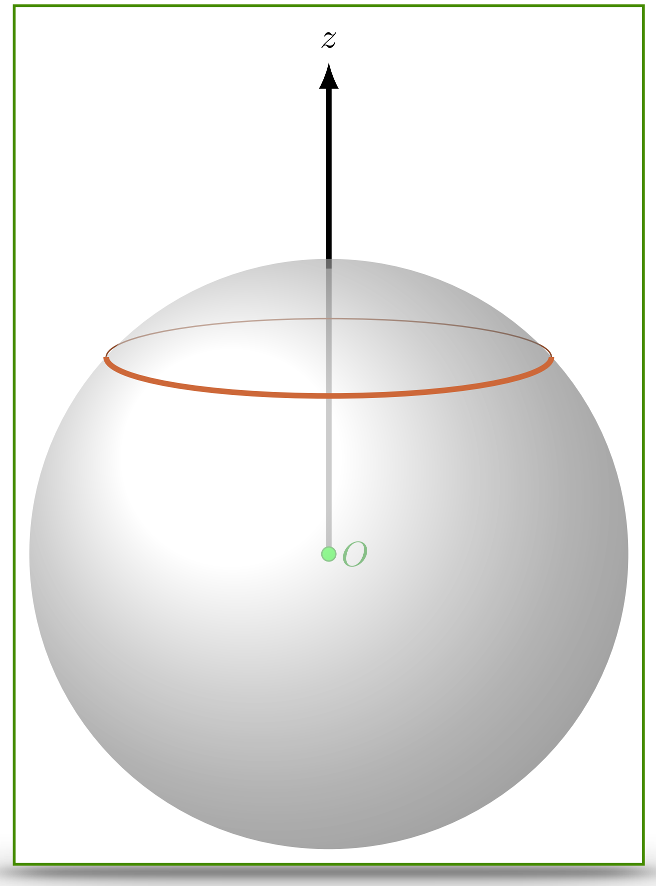


$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{r}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{A}} \frac{\sigma}{d}\,\mathrm{d}A$$

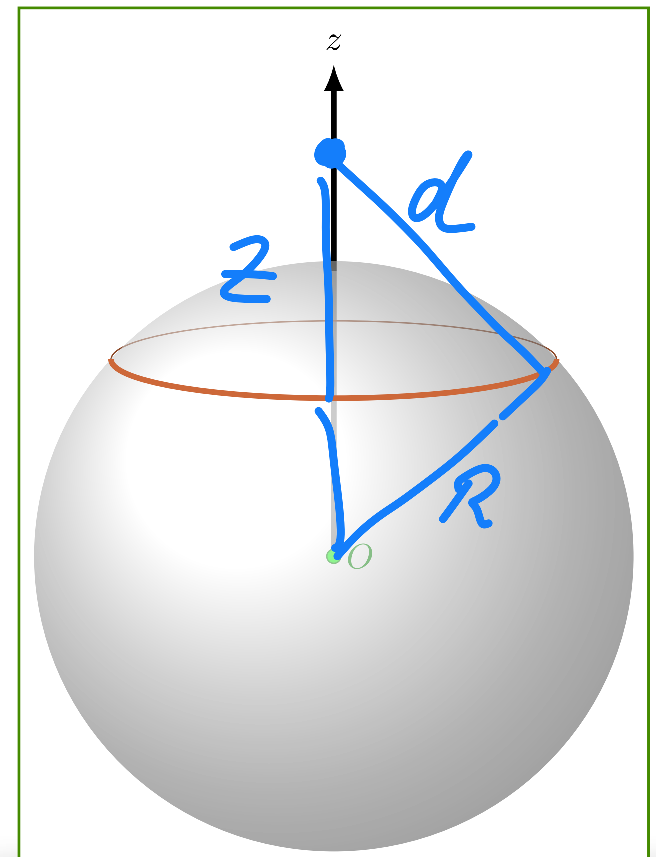


$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

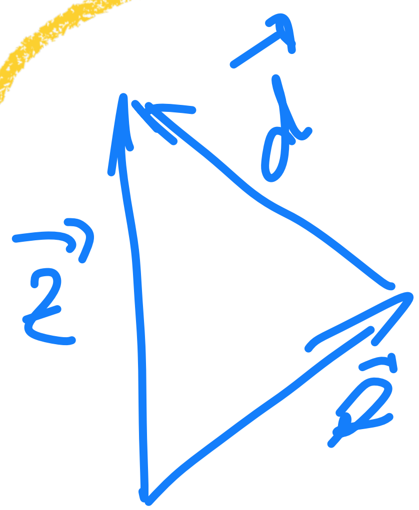
Pratique o que aprendeu

Potencial de uma casca esférica

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{A}} \frac{\sigma}{d}\,\mathrm{d}A$$



$$d^2 = R^2 + z^2 - 2\vec{z}\cdot\vec{R}$$



$$\vec{z} = \vec{R} + \vec{d} \Rightarrow \vec{d} = \vec{z} - \vec{R}$$

$$\Rightarrow d^2 = (\vec{z} - \vec{R})\cdot(\vec{z} - \vec{R})$$

$$= z^2 + R^2 - 2\,\vec{z}\cdot\vec{R}$$

$$V(P) = \frac{1}{4\pi\epsilon_0} \int_{\mathcal{V}} \frac{1}{r} \, \mathrm{d}q$$

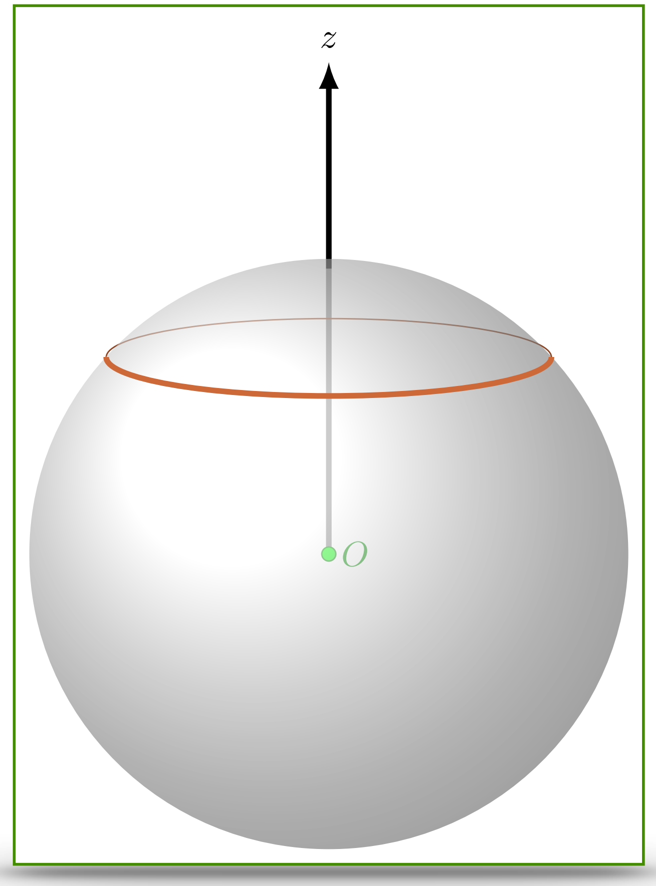
Pratique o que aprendeu

Potencial de uma casca esférica

$$V(P) = \frac{1}{4\pi\epsilon_0} \int_{\mathcal{A}} \frac{\sigma}{d} \, \mathrm{d}A$$

$$d^2 = R^2 + z^2 - 2\vec{z} \cdot \vec{R}$$

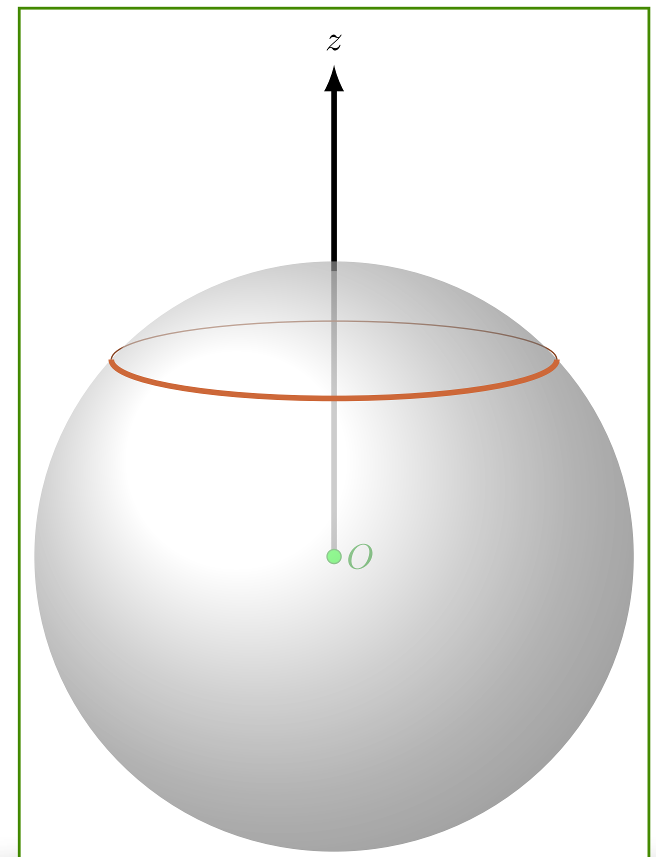
$$d = \sqrt{R^2 + z^2 - 2zR\cos\theta}$$



$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica



$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{A}} \frac{\sigma}{d}\,\mathrm{d}A$$

$$d^2 = R^2 + z^2 - 2\vec{z}\cdot\vec{R}$$

$$d = \sqrt{R^2 + z^2 - 2zR\cos\theta}$$

$$V = \frac{\sigma}{4\pi\epsilon_0}\int_0^{2\pi}\int_{-1}^{1} \frac{R^2}{\sqrt{R^2+z^2-2zRu}}\,\mathrm{d}u\,\mathrm{d}\phi$$

$d\tau = R^2 \operatorname{sen}\theta\, d\theta\, d\phi\, dr$

$= dA\, dr$

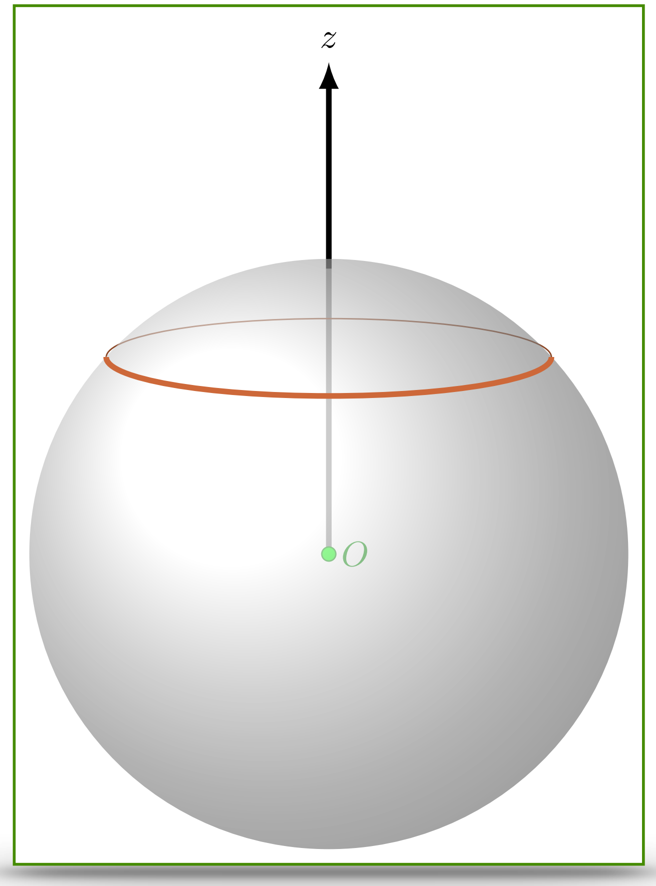
$\Rightarrow dA = R^2 \operatorname{sen}\theta\, d\theta\, d\phi$

$u = \cos\theta \Rightarrow \operatorname{sen}\theta\, d\theta = -du$

$$V(P) = \frac{1}{4\pi\epsilon_0} \int_{\mathcal{V}} \frac{1}{r}\, \mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica



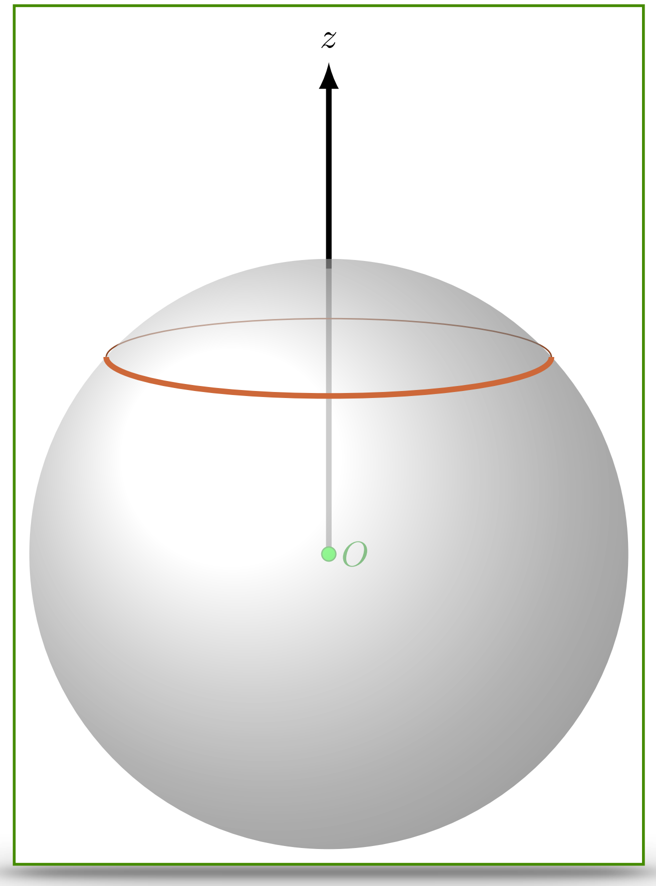
$$V = \frac{\sigma}{4\pi\epsilon_0} \int_0^{2\pi} \int_{-1}^{1} \frac{R^2}{\sqrt{R^2 + z^2 - 2zRu}}\, \mathrm{d}u\, \mathrm{d}\phi$$

$$V(P) = \frac{1}{4\pi\epsilon_0} \int_{\mathcal{V}} \frac{1}{r} \, \mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0} \int_0^{2\pi} \int_{-1}^{1} \frac{R^2}{\sqrt{R^2 + z^2 - 2zRu}} \, \mathrm{d}u \, \mathrm{d}\phi$$



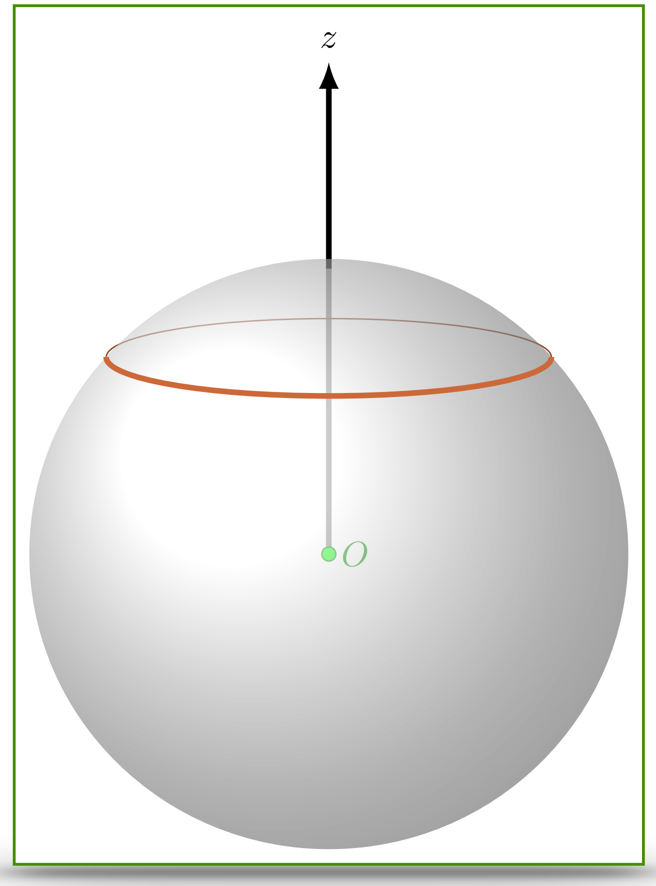
$$V(P) = \frac{1}{4\pi\epsilon_0} \int_{\mathcal{V}} \frac{1}{r} \, \mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0} \int_0^{2\pi} \int_{-1}^{1} \frac{R^2}{\sqrt{R^2 + z^2 - 2zRu}} \, \mathrm{d}u \, \mathrm{d}\phi$$

$$w = R^2 + z^2 - 2zRu$$

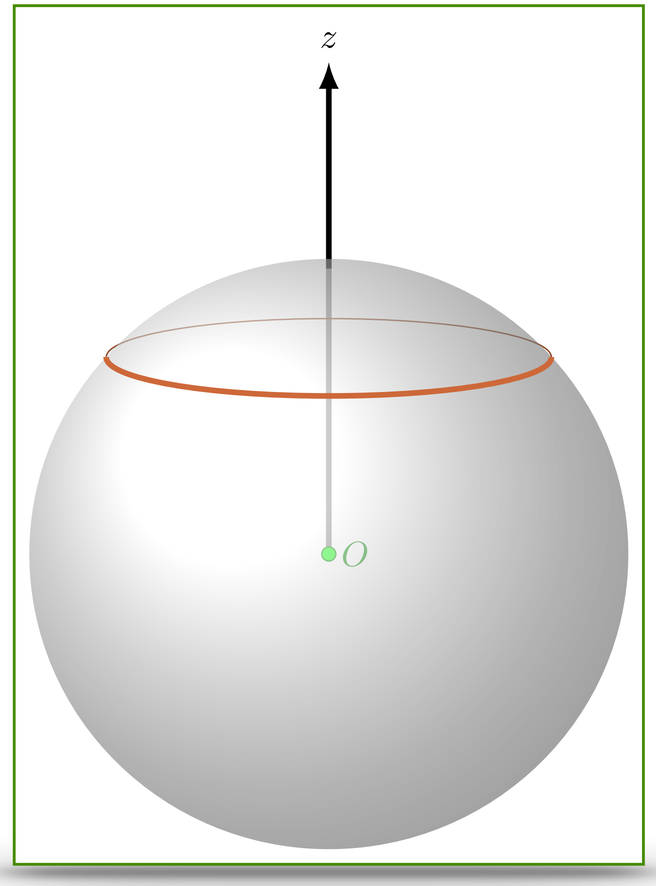


$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0}\int_0^{2\pi}\int_{-1}^{1}\frac{R^2}{\sqrt{R^2+z^2-2zRu}}\,\mathrm{d}u\,\mathrm{d}\phi$$



$$w = R^2 + z^2 - 2zRu$$

$$\mathrm{d}w = -2zR\,\mathrm{d}u$$

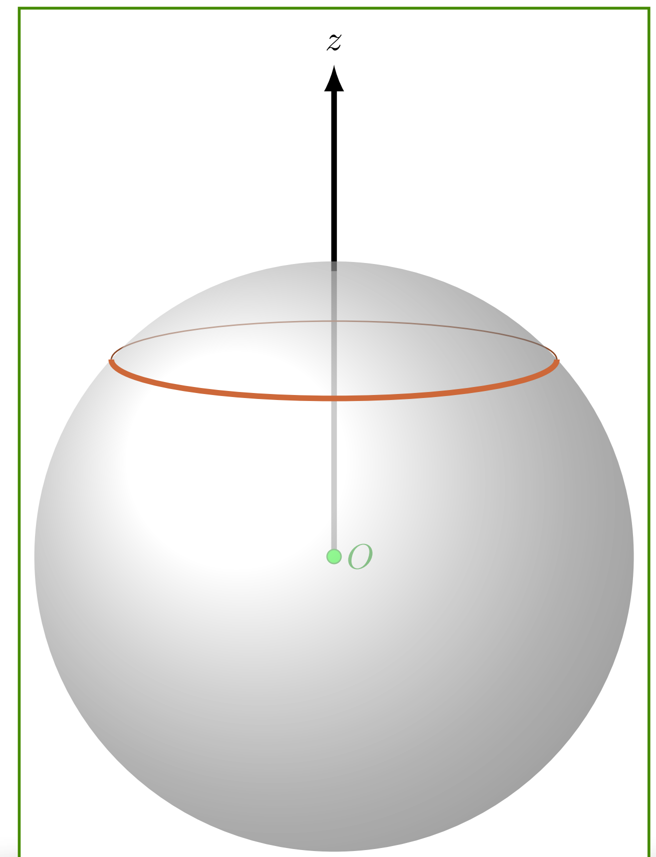
$$w = \begin{cases}(z-R)^2 & (u=1)\\ (z+R)^2 & (u=-1)\end{cases}$$

Pratique o que aprendeu

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0}\int_0^{2\pi}\int_{-1}^{1}\frac{R^2}{\sqrt{R^2+z^2-2zRu}}\,\mathrm{d}u\,\mathrm{d}\phi$$



$$w = R^2 + z^2 - 2zRu$$

$$V = \frac{2\pi\sigma}{4\pi\epsilon_0}\frac{(-R)}{2z}\int_{(z+R)^2}^{(z-R)^2}\frac{\mathrm{d}w}{\sqrt{w}}$$

$$\frac{R^2}{-2zR}$$

$$\mathrm{d}w = -2zR\,\mathrm{d}u$$

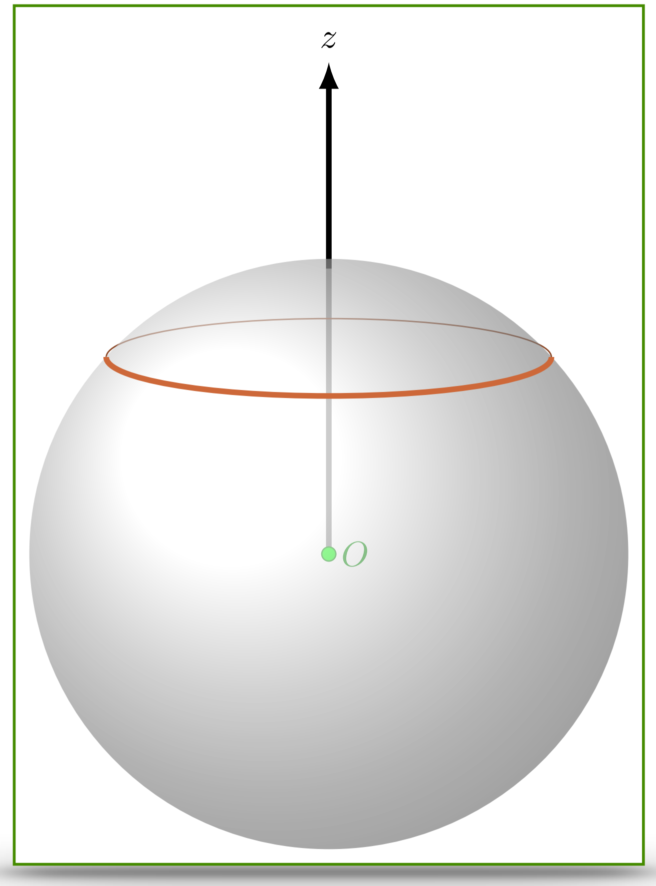
$$w = \begin{cases}(z-R)^2 & (u=1)\\ (z+R)^2 & (u=-1)\end{cases}$$

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0}\int_0^{2\pi}\int_{-1}^{1}\frac{R^2}{\sqrt{R^2+z^2-2zRu}}\,\mathrm{d}u\,\mathrm{d}\phi$$



$$w = R^2 + z^2 - 2zRu$$

$$V = \frac{2\pi\sigma}{4\pi\epsilon_0}\frac{(-R)}{2z}\int_{(z+R)^2}^{(z-R)^2}\frac{\mathrm{d}w}{\sqrt{w}}$$

$$V = \frac{\sigma}{4\epsilon_0}\frac{(-R)}{z}\left(2\sqrt{w}\right)_{(z+R)^2}^{(z-R)^2}$$

$$\mathrm{d}w = -2zR\,\mathrm{d}u$$

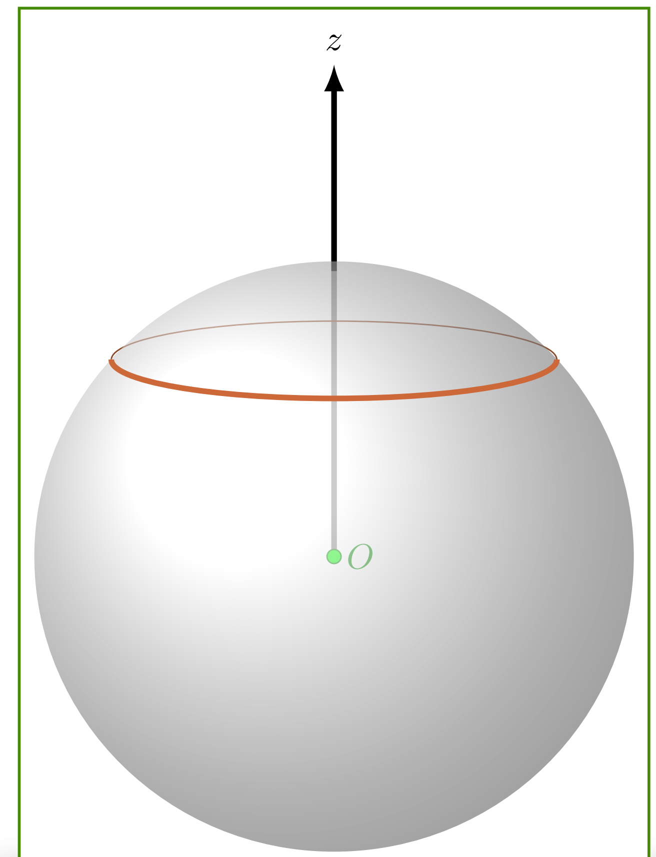
$$w = \begin{cases}(z-R)^2 & (u=1)\\ (z+R)^2 & (u=-1)\end{cases}$$

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0}\int_0^{2\pi}\int_{-1}^{1}\frac{R^2}{\sqrt{R^2+z^2-2zRu}}\,\mathrm{d}u\,\mathrm{d}\phi$$



$$w = R^2 + z^2 - 2zRu$$

$$V = \frac{2\pi\sigma}{4\pi\epsilon_0}\frac{(-R)}{2z}\int_{(z+R)^2}^{(z-R)^2}\frac{\mathrm{d}w}{\sqrt{w}}$$

$$V = \frac{\sigma}{4\epsilon_0}\frac{(-R)}{z}\left(2\sqrt{w}\right)_{(z+R)^2}^{(z-R)^2} = \frac{\sigma}{\epsilon_0}\frac{R}{2z}\left(z+R-|z-R|\right)$$

$$|z-R| = \begin{cases} z-R & (z>R) \\ R-z & (z<R) \end{cases}$$

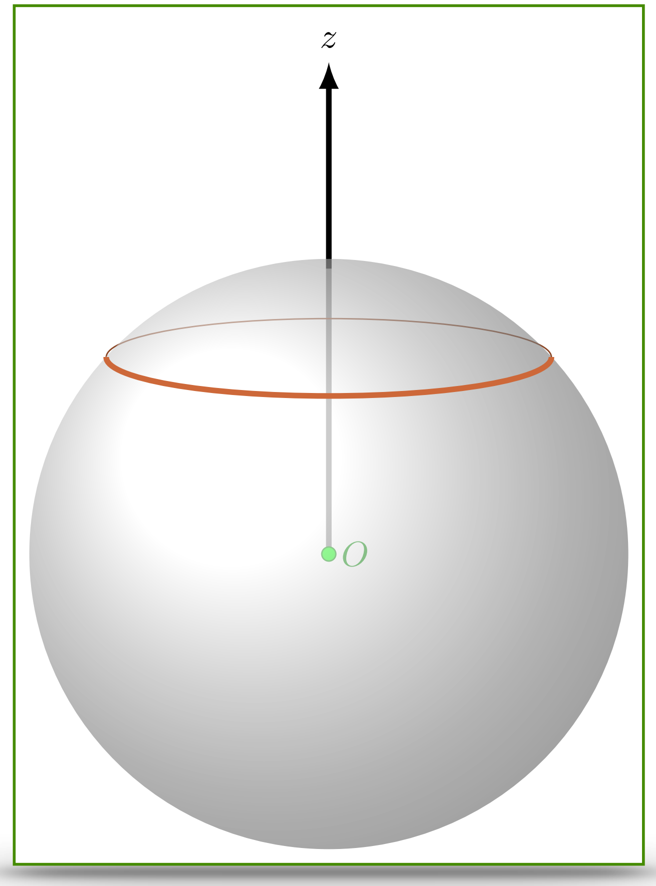
$$z > R \Rightarrow V = \frac{\sigma}{\epsilon_0}\frac{R}{2z}\left(z+R-(z-R)\right) = \frac{\sigma}{\epsilon_0}\frac{R^2}{z}$$

$$V(P) = \frac{1}{4\pi\epsilon_0}\int_{\mathcal{V}} \frac{1}{\mathscr{r}}\,\mathrm{d}q$$

Pratique o que aprendeu

Potencial de uma casca esférica

$$V = \frac{\sigma}{4\pi\epsilon_0}\int_0^{2\pi}\int_{-1}^{1}\frac{R^2}{\sqrt{R^2+z^2-2zRu}}\,\mathrm{d}u\,\mathrm{d}\phi$$



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$$V = \frac{\sigma}{4\epsilon_0}\frac{(-R)}{z}\left(2\sqrt{w}\right)_{(z+R)^2}^{(z-R)^2}$$

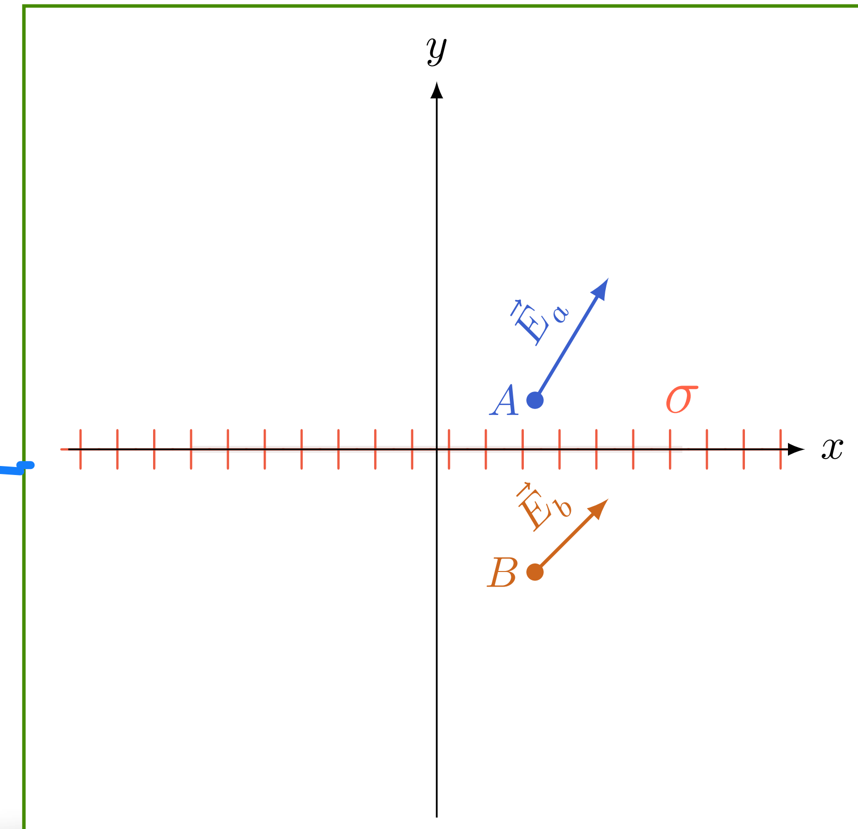
$$|z-R| = R-z \quad (z \leq R)$$

$$z < R \Rightarrow V = \frac{\sigma}{\epsilon_0}\frac{R}{2z}\left(z + R - (R-z)\right) = \frac{\sigma}{\epsilon_0}R$$

→ CONSTANTE ⇒ $\vec{E} = 0$

Condições de contorno

Descontinuidade do campo elétrico



SUPERFÍCIE CARREGADA QUALQUER, VISTA TÃO DE PERTO QUE PARECE PLANA E INFINITA

Condições de contorno

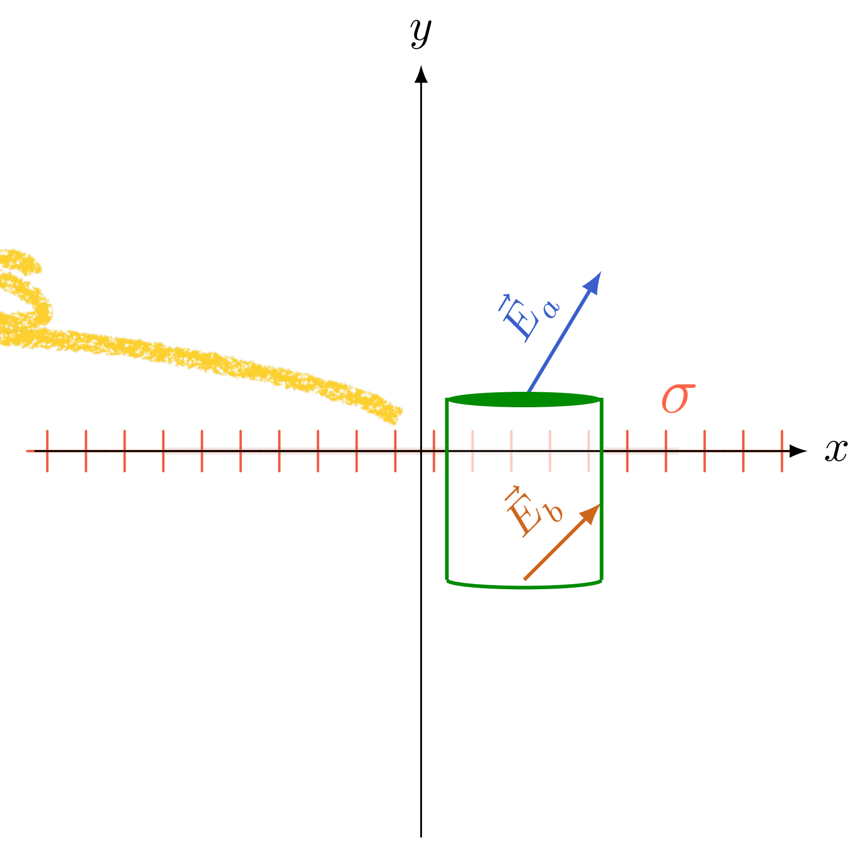
Descontinuidade do campo elétrico

$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

GAUSS

FLUXO ATRAVÉS DAS TAMPAS

CARGA NO INTERIOR DO CILINDRO



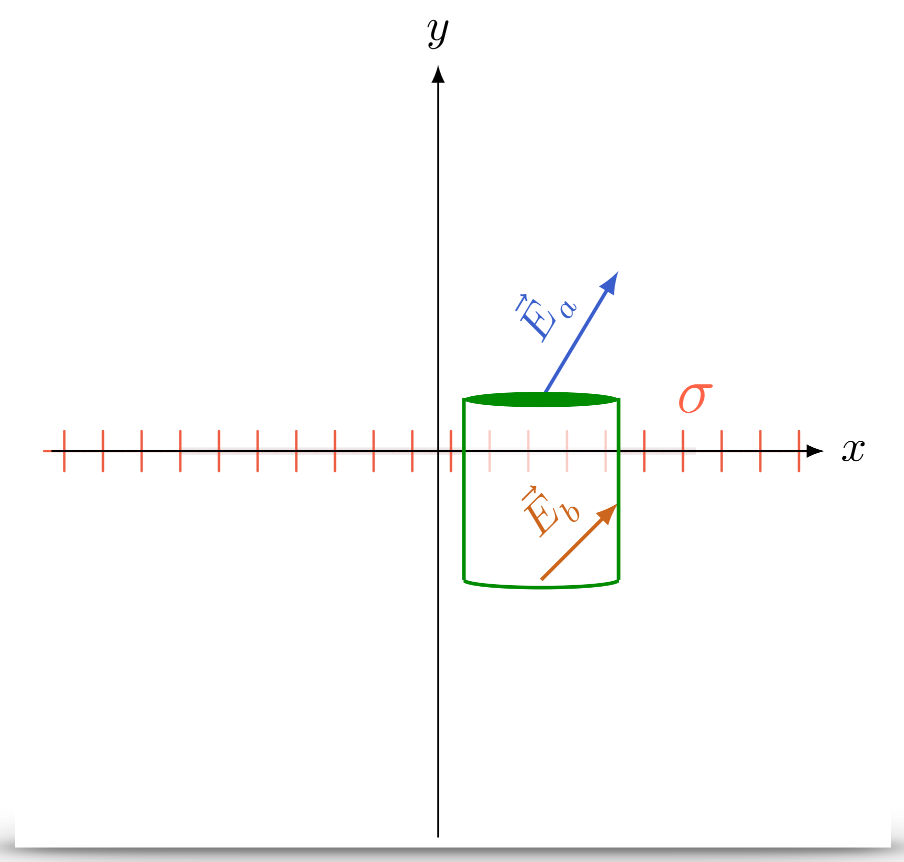
FLUXO ATRAVÉS DA PAREDE LATERAL É MUITO PEQUENO, PQ ALTURA É INFINITESIMAL

Condições de contorno

Descontinuidade do campo elétrico

$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

$$\Delta E_y = \frac{\sigma}{\epsilon_0}$$



Condições de contorno

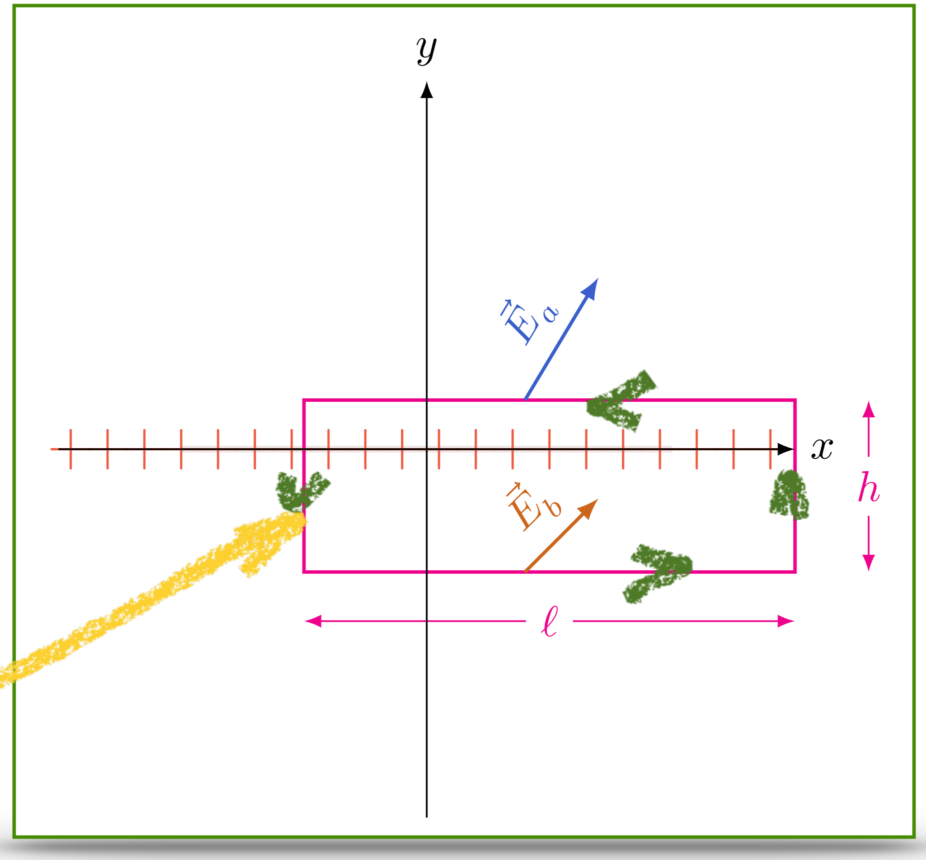
Descontinuidade do campo elétrico

$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

$$\Delta E_y = \frac{\sigma}{\epsilon_0}$$

$$\vec{\nabla} \times \vec{E} = 0$$

STOKES NO CIRCUITO



Condições de contorno

Descontinuidade do campo elétrico

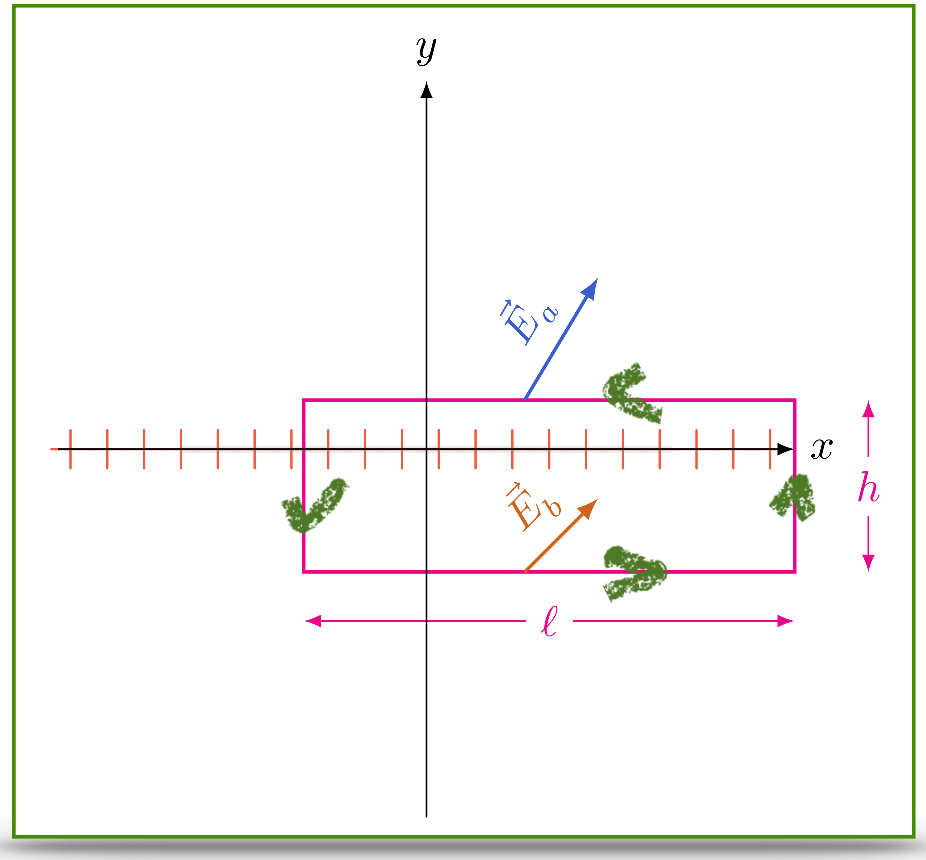
$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

$$\Delta E_y = \frac{\sigma}{\epsilon_0}$$

$$\vec{\nabla} \times \vec{E} = 0$$

$$E_{x,b}\ell + E_y h - E_{x,a}\ell - E_y h = 0$$

TÃO PEQUENOS QUANTO QUISERMOS



Condições de contorno

Descontinuidade do campo elétrico

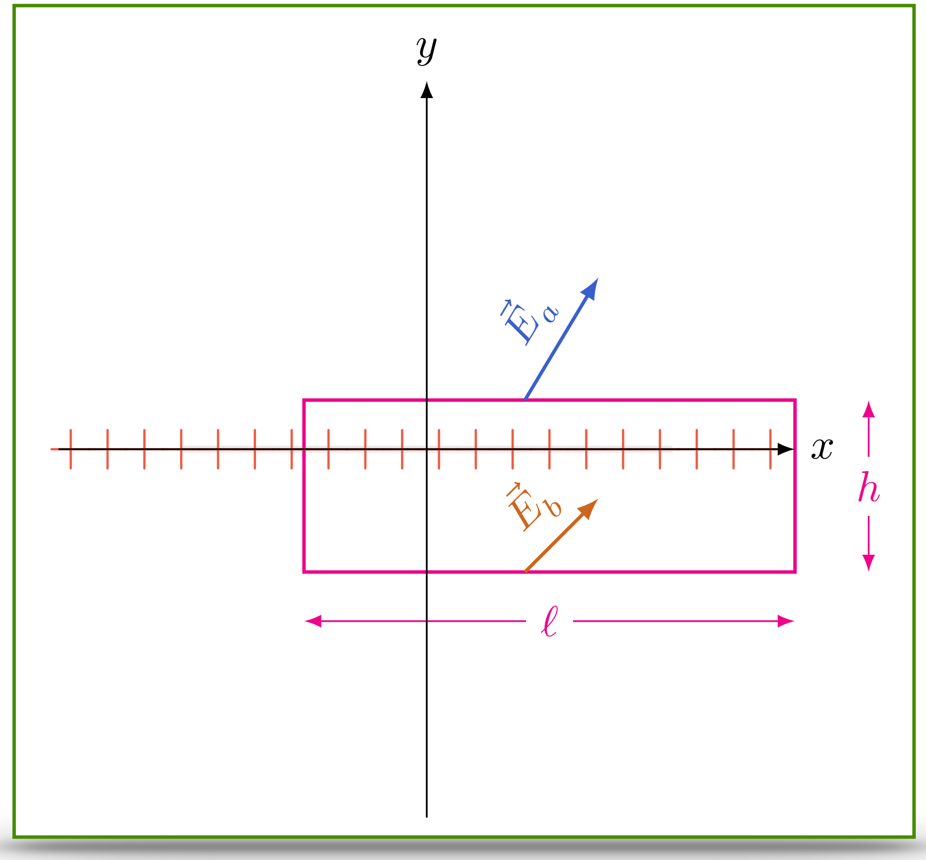
$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

$$\Delta E_y = \frac{\sigma}{\epsilon_0}$$

$$\vec{\nabla} \times \vec{E} = 0$$

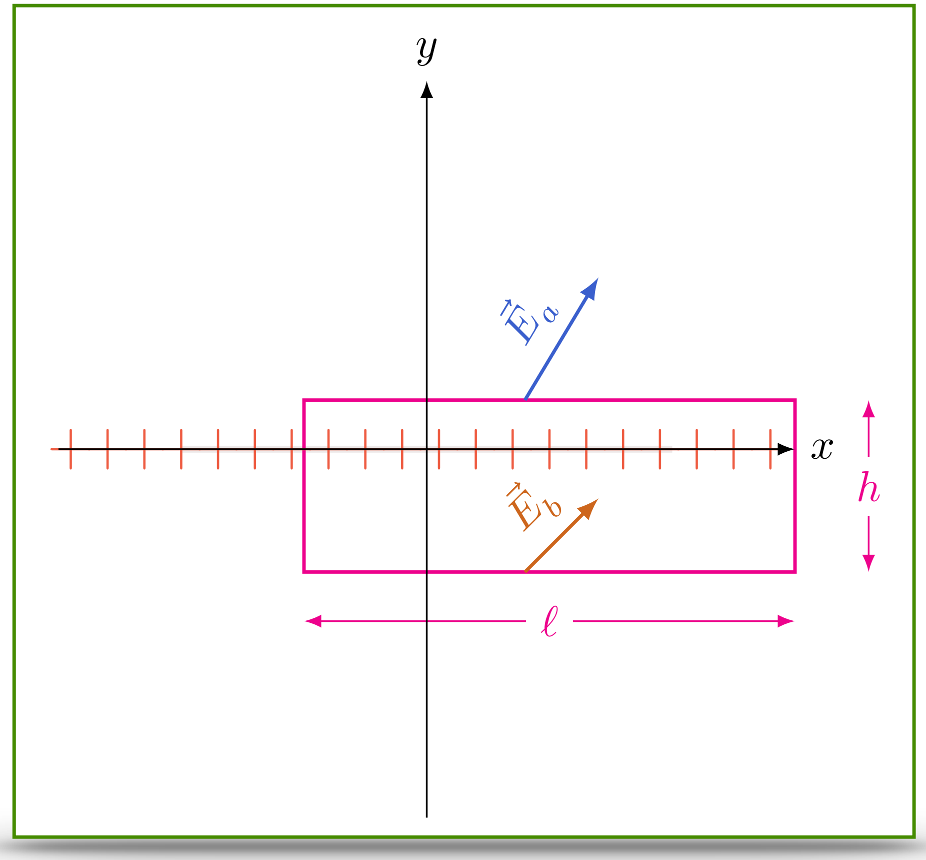
$$E_{x,b}\ell + E_y h - E_{x,a}\ell - E_y h = 0$$

$$\Rightarrow (E_{x,b} - E_{x,a})\ell = 0$$



Condições de contorno

Descontinuidade do campo elétrico



$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

$$\Delta E_y = \frac{\sigma}{\epsilon_0}$$

$$E_{x,b}\ell + E_y h - E_{x,a}\ell - E_y h = 0$$

$$(E_{x,b} - E_{x,a})\ell = 0$$

$$\Delta E_x = 0$$

$$\Delta \vec{E} \cdot \hat{n} = \frac{\sigma}{\epsilon_0}$$

$\hat{n} = \hat{y}$

$\Delta E_z = 0$ (PERPENDICULAR À TELA)

Condições de contorno

Descontinuidade do campo elétrico

$$E_{y,a}A - E_{y,b}A = \frac{\sigma A}{\epsilon_0}$$

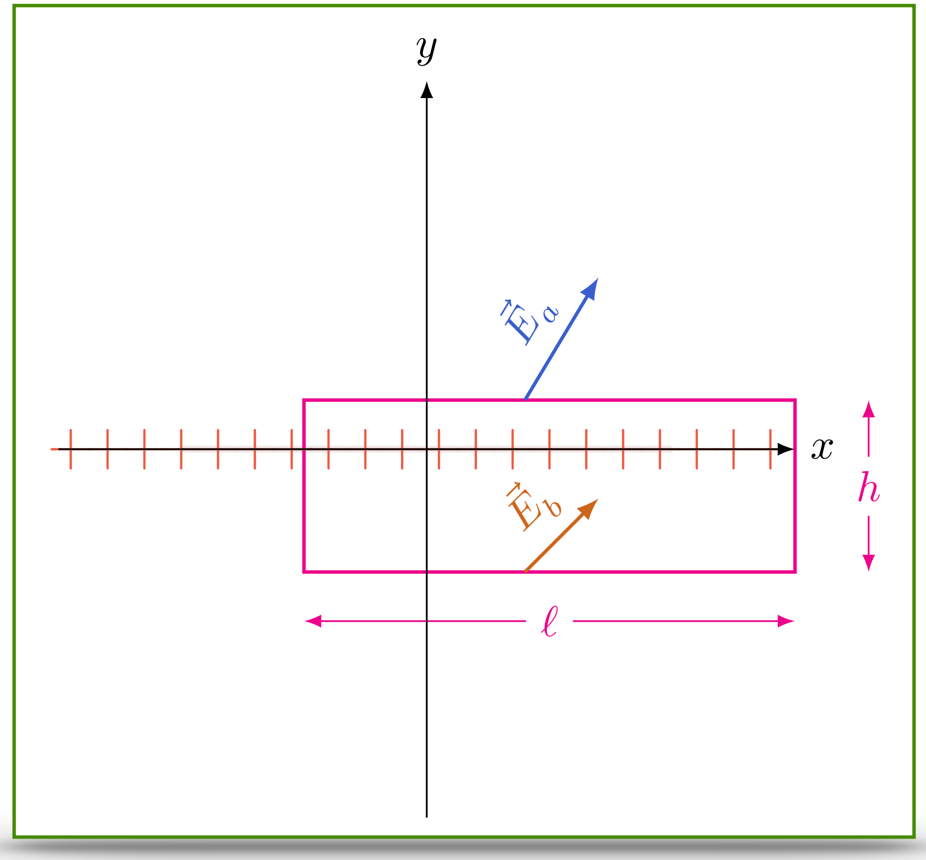
$$\Delta E_y = \frac{\sigma}{\epsilon_0}$$

$$\vec{\nabla} \times \vec{E} = 0$$

$$E_{x,b}\ell + E_y h - E_{x,a}\ell - E_y h = 0$$

$$(E_{x,b} - E_{x,a})\ell = 0$$

$$\Delta E_x = 0$$



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

$$\vec{\nabla} \times \vec{E} = 0$$

$$\Delta \vec{E} \cdot \hat{n} = \frac{\sigma}{\epsilon_0}$$