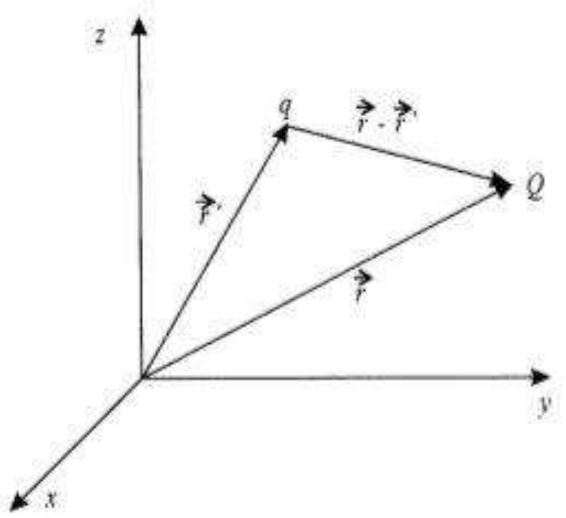
REVISÂO

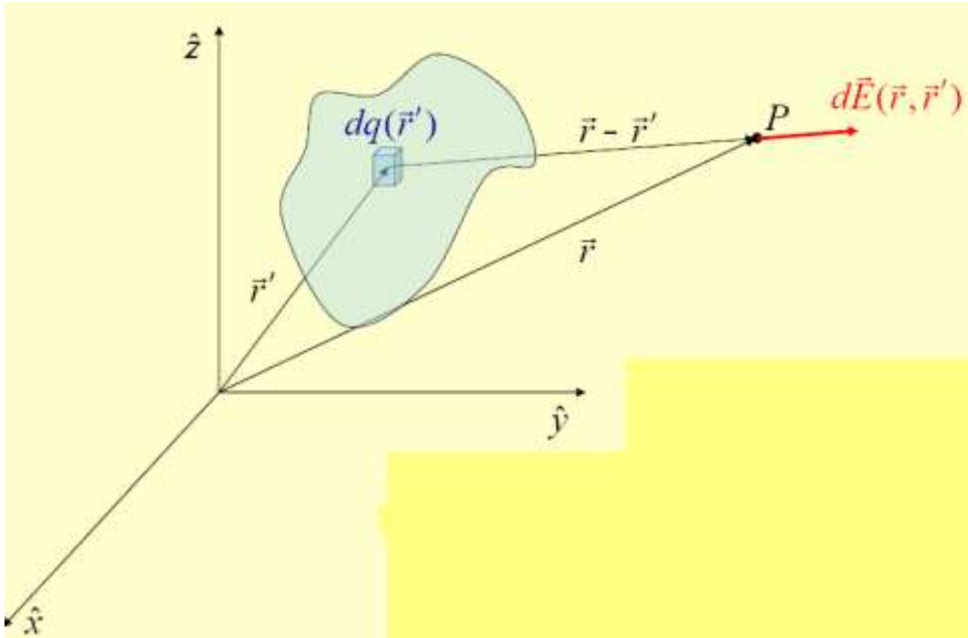
Lei de Coulomb



$$\vec{F} = \frac{qQ}{4\pi\varepsilon_0}\frac{(\vec{r}-\vec{r}^{\,`})}{|\vec{r}-\vec{r}^{\,`}|^3}$$

O campo elétrico

Distribuição contínua de cargas



$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{(\vec{r} - \vec{r}\,')dq}{|\vec{r} - \vec{r}\,'|^3}$$

Linha de carga:

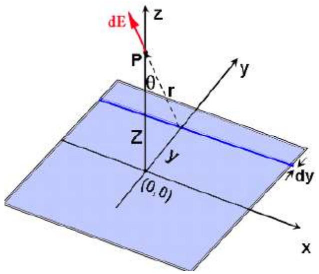
λ = carga/m

$dq = \lambda\, dx$

$$\vec{E} = \frac{2\lambda}{4\pi\varepsilon_0}\frac{\vec{R}}{R^2}$$

$$|E| = \frac{2\lambda}{4\pi\varepsilon_0}\frac{1}{R}$$

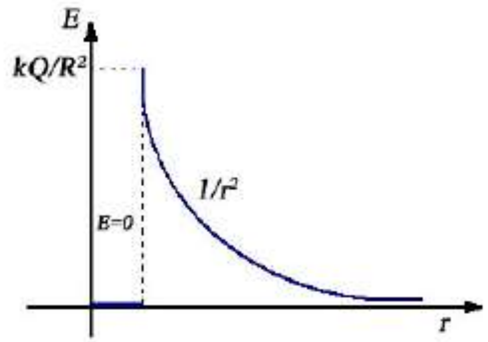
Plano infinito de carga dq=σdS



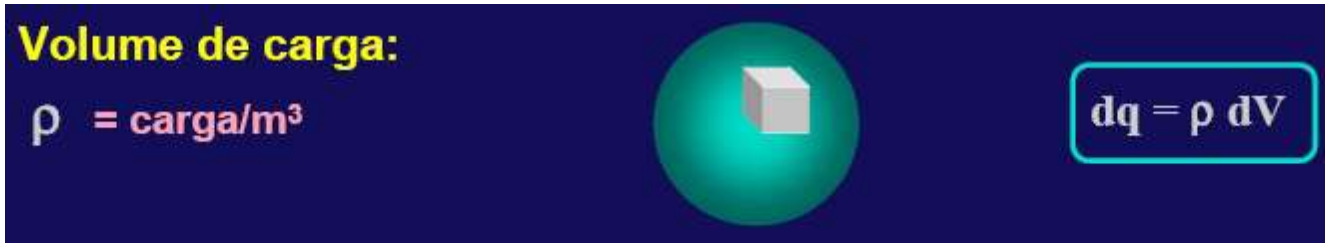
$$\vec{E} = \frac{\sigma}{2\varepsilon_0}\frac{\overrightarrow{|z|}}{Z} \qquad |E| = \frac{\sigma}{2\varepsilon_0}$$

Casca esferica de carga dq=σdS

Dentro E=0 ; Fora $\vec{E} = \frac{4\pi a^2 \sigma}{4\pi\varepsilon_0}\frac{\vec{R}}{R^3} = \frac{Q}{4\pi\varepsilon_0}\frac{\vec{R}}{R^3}$; $|E| = \frac{Q}{4\pi\varepsilon_0}\frac{1}{R^2}$



Esfera maciça de carga

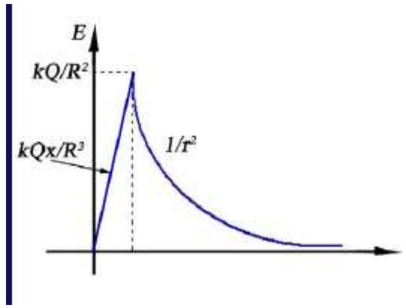


Dentro

$$\vec{E} = \frac{\rho}{3\varepsilon_0}\vec{R} = \frac{Q}{4\pi\varepsilon_0}\frac{\vec{R}}{a^3};$$

Fora

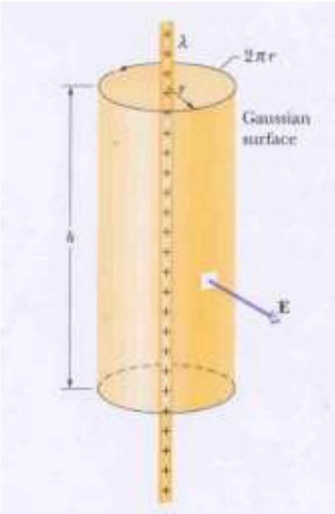
$$\vec{E} = \frac{Q}{4\pi\varepsilon_0}\frac{\vec{R}}{R^3}\ ;\ |E| = \frac{Q}{4\pi\varepsilon_0}\frac{1}{R^2}$$



Lei de Gauss

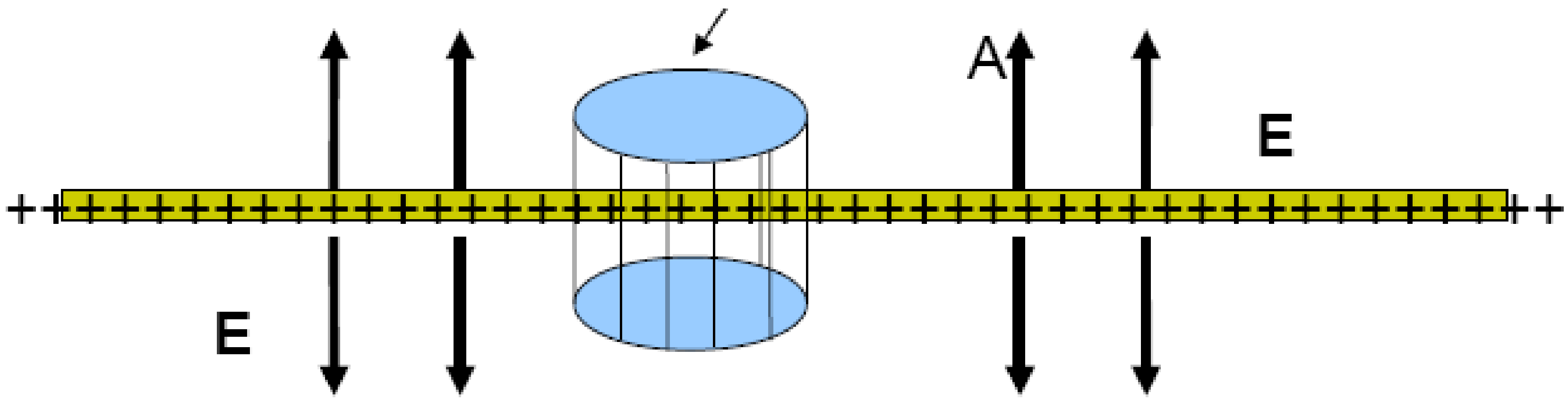
$$\int (\vec{E} * \overrightarrow{dS}) = \frac{Q_{total}}{\varepsilon_0}$$

Linha de carga



$$\int (\vec{E} * \overrightarrow{dS}) = E(2\pi RL) = \frac{\lambda L}{\varepsilon_0}; |E| = \frac{2\lambda}{4\pi\varepsilon_0}\frac{1}{R}$$

Plano infinito de carga



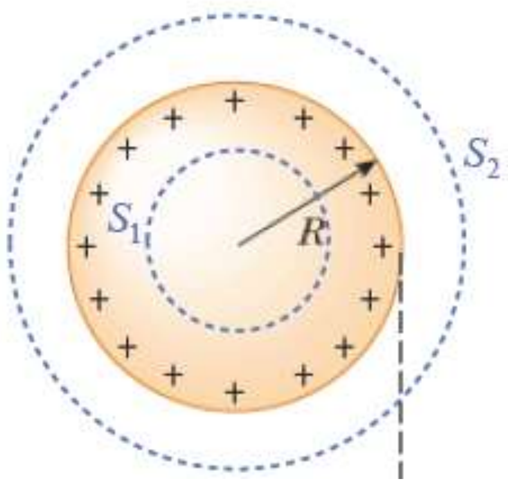
$$\int \left(\vec{E} * \overrightarrow{dS}\right) = E(S) + (-E)(-S) = 2ES = \frac{\sigma S}{\varepsilon_o}; |E| = \frac{\sigma}{2\varepsilon_o}$$

Casca esférica de carga

Dentro E=0

Fora

$$\int (\vec{E} * \overrightarrow{dS}) = E(4\pi R^2) = \frac{Q}{\varepsilon_0} \;\; ; |E| = \frac{1}{4\pi\varepsilon_0}\frac{1}{R}$$



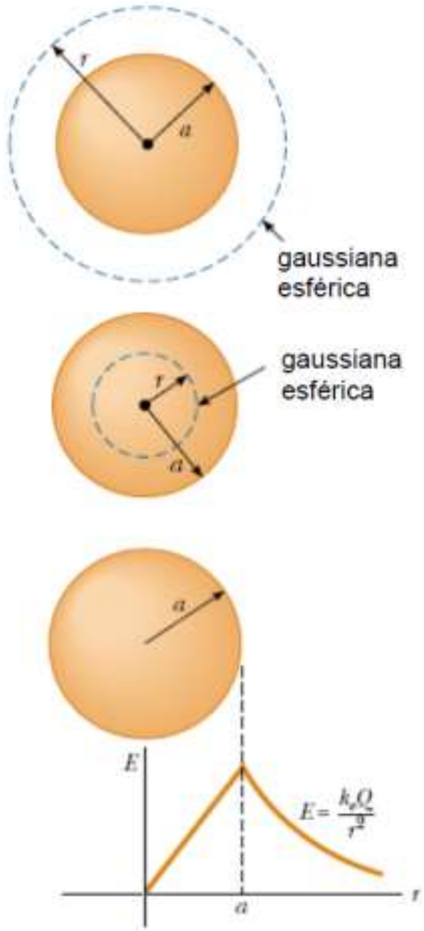
Esfera maciça de carga

Dentro

$$\int \left(\vec{E} * \overrightarrow{dS}\right) = E(4\pi R^2) = \frac{Q}{\varepsilon_0}$$

$$= \frac{1}{\varepsilon_0}\int_0^R \rho dV = \frac{1}{\varepsilon_0}\int_0^R \rho 4\pi R^2 dR = \frac{4\pi\rho R^3}{3\varepsilon_0};\ |E| = \frac{\rho R}{3\varepsilon_0}$$

Fora

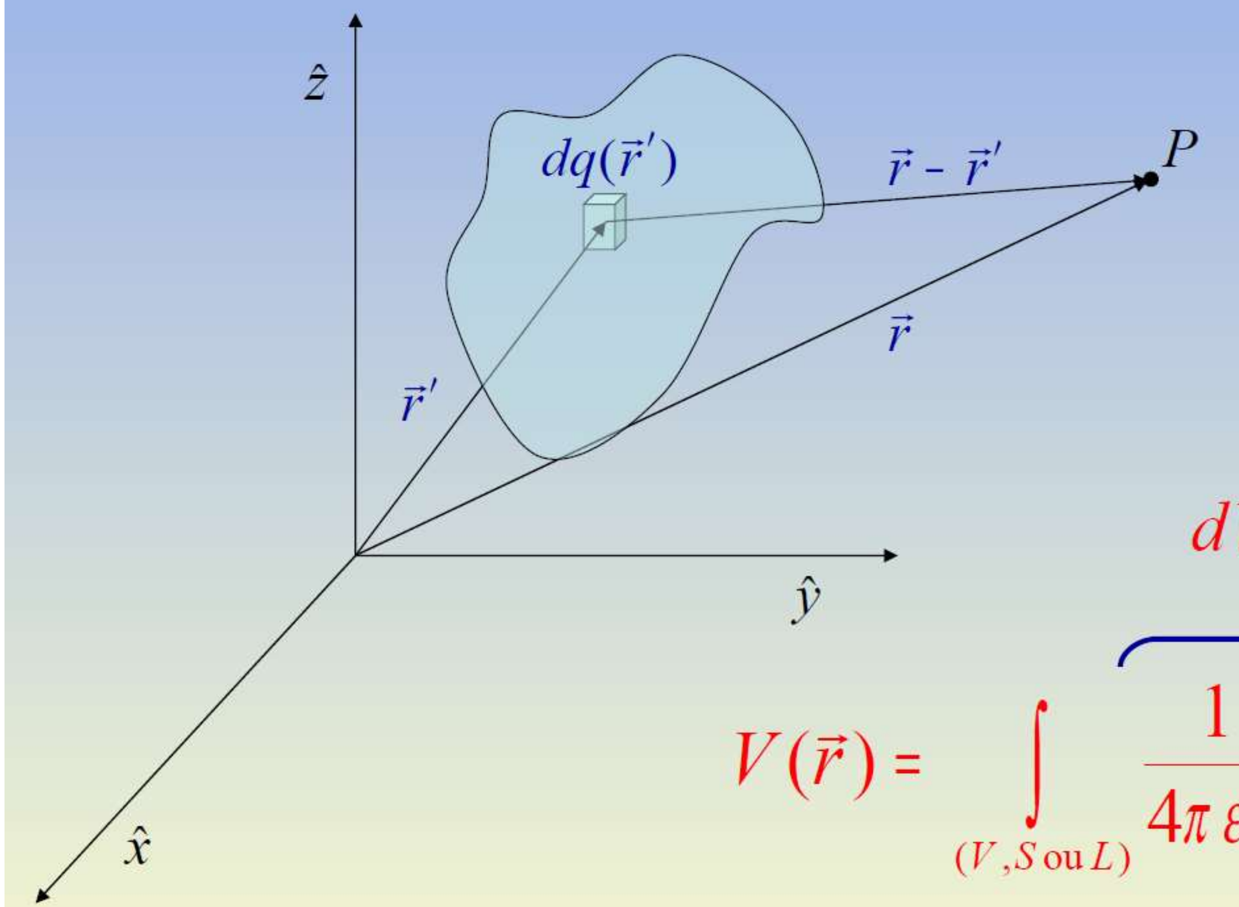


$$\int \left(\vec{E} * \overrightarrow{dS}\right) = E(4\pi R^2) = \frac{Q}{\varepsilon_0}$$

$$= \frac{1}{\varepsilon_0}\int_a^{\infty} \rho dV$$

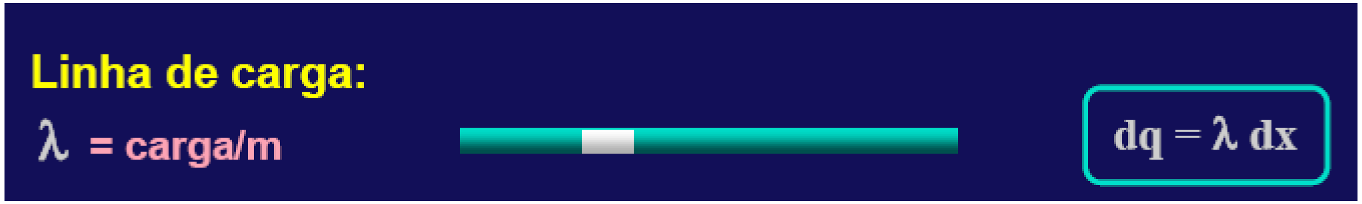
$$= \frac{1}{\varepsilon_0}\int_a^{\infty} \rho 4\pi R^2 dR = \frac{4\pi\rho a^3}{3\varepsilon_0};\ |E| = \frac{Q}{4\pi\varepsilon_0}\frac{1}{R^2}$$

O Potencial Eléctrico



$$V(\vec{r}) = \int_{(V,S\,\text{ou}\,L)} \overbrace{\frac{1}{4\pi\varepsilon_0}\frac{dq(\vec{r}\,')}{|\vec{r}-\vec{r}\,'|}}^{dV(\vec{r},\vec{r}\,')}$$

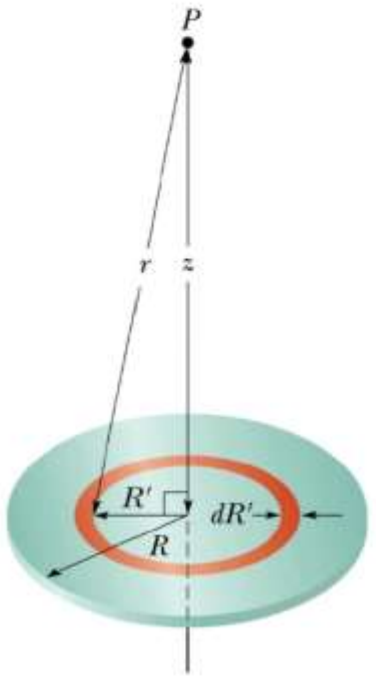
Linha de carga



$$V = \frac{\lambda}{4\pi\varepsilon_0} ln \frac{\sqrt{x^2+a^2}+a}{\sqrt{x^2+a^2}-a}$$

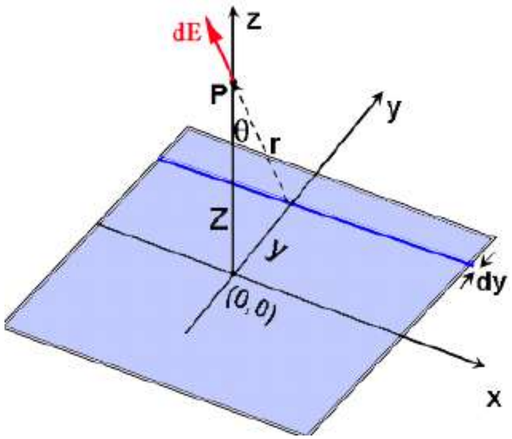
$$a \to \infty \,;\; \Delta V = V(R_2) - V(R_1) = \frac{2\lambda}{4\pi\varepsilon_0} ln \frac{R_1}{R_2}$$

Disco de carga dq=σdS



$$V = \frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2 + a^2} - |z|\right)$$

Plano infinito de carga dq=σdS



$$\Delta V = V(z) - V(0) = \frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2 + a^2} - |z|\right) - \frac{\sigma}{2\varepsilon_0} a =$$
$$-\frac{\sigma}{2\varepsilon_0}|z|; \quad a \to \infty$$

CÁLCULO DO POTENCIAL A PARTIR DO CAMPO ELÉTRICO

$$V(R) - V(\infty) = -\int_{\infty}^{R} \vec{E}\,\overrightarrow{dl}\,; \;\; \vec{E} = \; -\vec{\nabla}V$$

$$= -\frac{\partial V}{\partial x}\hat{\imath} - \frac{\partial V}{\partial y}\hat{\jmath} - \frac{\partial V}{\partial z}\hat{k}$$

Casca esférica de carga

Dentro

$$V(R) - V(\infty) = -\int_{\infty}^{R} \vec{E}\,\overrightarrow{dR} = \frac{Q}{4\pi\varepsilon_0}\frac{1}{a}$$

Fora

$$V(R) - V(\infty) = -\int_{\infty}^{R} \vec{E}\,\overrightarrow{dR} = \frac{Q}{4\pi\varepsilon_0}\frac{1}{R}$$

Esfera maciça de carga

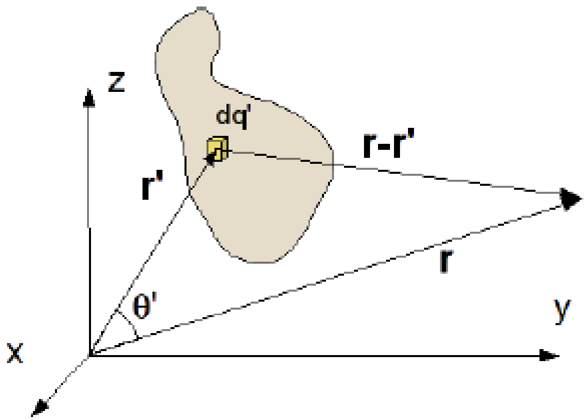
Dentro

$$V(R) - V(\infty) = -\int_{\infty}^{R} \vec{E}\,\overrightarrow{dR} = \frac{Q}{8\pi\varepsilon_0}\left(3 - \frac{R^2}{a^2}\right)$$

Fora

$$V(R) - V(\infty) = -\int_{\infty}^{R} \vec{E}\,\overrightarrow{dR} = \frac{Q}{4\pi\varepsilon_0}\frac{1}{R}$$

Expansão Multipolar, Dipolo elétrico



$$V = \frac{q}{4\pi\varepsilon_0}\frac{1}{|\vec{R} - \overrightarrow{R'}|} = \frac{q}{4\pi\varepsilon_0}\frac{1}{\sqrt{R + R'^2 - 2RR'cos\theta}}$$

$$= \frac{q}{4\pi\varepsilon_0}\frac{1}{R\sqrt{1 + \frac{R'^2}{R^2} - 2\frac{R'}{R}cos\theta}}$$

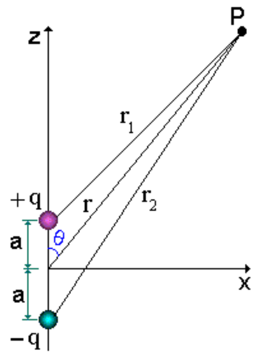
$$\approx \frac{q}{4\pi\varepsilon_0}\frac{1}{R}\left(1 + \frac{R'}{R}cos\theta\right) = \frac{q}{4\pi\varepsilon_0}\frac{1}{R}\left(1 + \frac{\left(\overrightarrow{R'}\vec{R}\right)}{R^2}\right)$$

$$= \frac{q}{4\pi\varepsilon_0}\frac{1}{R} + \frac{1}{4\pi\varepsilon_0}\frac{(\vec{p}R)}{R^3}; \ \ \vec{p} = q\overrightarrow{R'}$$

$$V_{total} = \sum V_i = \frac{1}{4\pi\varepsilon_0}\frac{1}{R}\sum q_i + \frac{1}{4\pi\varepsilon_0}\frac{\left(\vec{p}\vec{R}\right)}{R^3}; \quad \vec{p} = \sum q_i \overrightarrow{R_i'} = \int \overrightarrow{R'} dq$$

$$Q = \sum q_i = 0; \quad \vec{E} = \frac{1}{4\pi\varepsilon_0}\left(-\frac{\vec{p}}{R^3} + \frac{3(\vec{p}\vec{R})\vec{R}}{R^5}\right)$$

Um dipolo elétrico é formado por duas cargas puntiformes



$$V = \frac{1}{4\pi\varepsilon_0}\frac{(\vec{p}\,\vec{R})}{R^3}$$

$$E_z = \frac{p_z}{4\pi\varepsilon_0}\frac{1}{R^3}(3cos^2\theta - 1);\ E_x = 0;\ E_y$$

$$= \frac{p_z}{4\pi\varepsilon_0}\frac{3}{R^3}cos\theta sin\theta;\ |E|$$

$$= \frac{p_z}{4\pi\varepsilon_0}\frac{1}{R^3}\sqrt{3cos^2\theta + 1};\ p_z = 2qa$$

Energia Eletrostática

$$W = \frac{1}{2}\sum_{i=1}^{n} q_i \sum_{j=n\neq i}^{n} \frac{q_j}{4\pi\varepsilon_0}\frac{1}{|\vec{R}_i - \vec{R}_j|}$$

$$W = \frac{1}{2}\int_0^{Volume} \varphi dq = \frac{\varepsilon_0}{2}\int_0^{\infty} |E^2| dV; \;\; \varphi - potencial\ elétrico;\ V - volume$$

Uma esfera uniformemente carregada

$$W = W_{dentro} + W_{fora} = \frac{1}{10}\frac{Q^2}{4\pi\varepsilon_0}\frac{1}{a} + \frac{1}{2}\frac{Q^2}{4\pi\varepsilon_0}\frac{1}{a} = \frac{3}{5}\frac{Q^2}{4\pi\varepsilon_0}\frac{1}{a}$$

Capacitância

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

Capacitor de placas paralelas

$$C = \frac{\varepsilon_0 S}{d};\ C = \frac{\varepsilon \varepsilon_0 S}{d}; S - area, d - \text{distância entre as placas};$$

$$\varepsilon - \text{constante dielétrica}$$

Capacitor cilíndrico

$$C = \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}; l \text{ é } o\ comprimento\ de\ capacitor$$

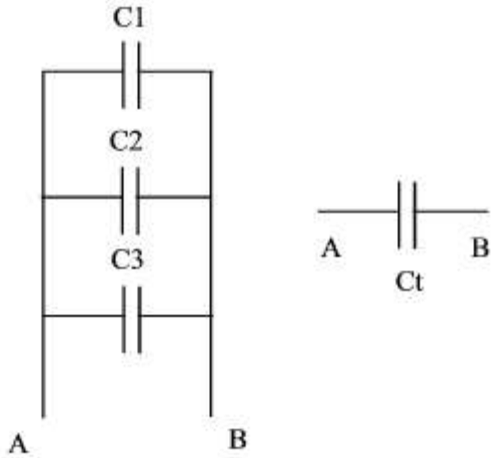
Capacitor esférico

$$C = 4\pi\varepsilon_0 \frac{ab}{(\mathrm{b}-\mathrm{a})}$$

Energia eletrostática armazenada

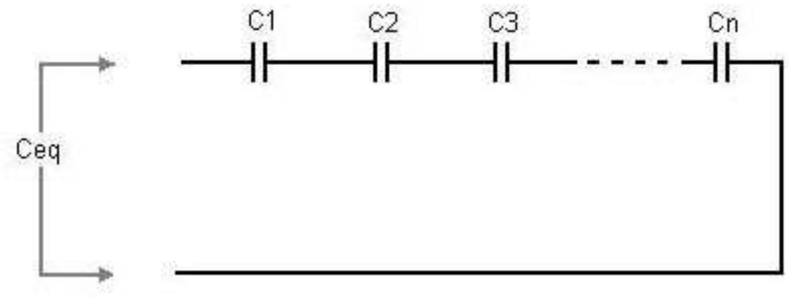
$$U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$$

Associação de capacitores paralelos



$$C = C_1 + C_2 + C_3 + C_4 + \ldots C_n$$

Associação de capacitores em série



$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \cdots \frac{1}{C_n}$$

Corrente elétrica, Lei de Ohm

$$I = \frac{dQ}{dt} = \frac{e^2 n\tau}{m}\frac{S}{L}V$$

$$V = IR;\ R = \frac{m}{e^2 n\tau}\frac{L}{S} = \rho\frac{L}{S}$$

$$\rho = \frac{m}{e^2 n\tau} = \frac{1}{\sigma};$$

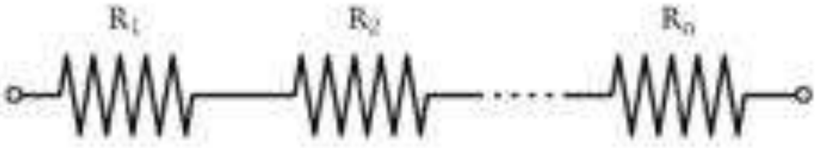
$$R - resistencia, \rho - resistividade, \sigma - condutividade$$

O efeito Joule

$$P = \frac{dW}{dt} = IV = I^2 R = \frac{V^2}{R}$$

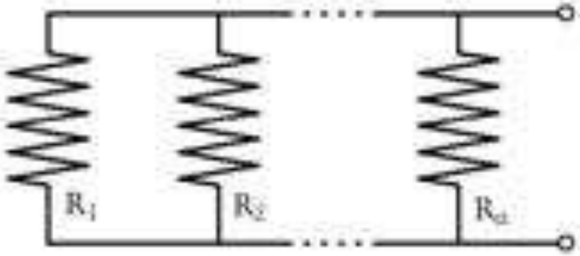
Associação de resistores

Série



$$R_t = R_1 + R_2 + R_3 + ... + R_n$$

Paralelo



$$1/R_t = 1/R_1 + 1/R_2 + ... + 1/R_n$$