Campo Elétrico

- $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \vec{u}$
- $\int \vec{E} \cdot \vec{n} \, ds = \frac{Q}{\varepsilon_0}$
- $\vec{E} = -\vec{\nabla}\phi$

Potencial

- $\phi_P = \int_P^\infty \vec{E} \cdot d\vec{l} = \int_P^\infty \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} dr = \frac{1}{4\pi\varepsilon_0} Q \left[-\frac{1}{r} \right]_R^\infty =$

$$= \frac{1}{4\pi\varepsilon_0} \frac{Q}{R} \, V$$

- $V_{AB} = \int_A^B \vec{E} \cdot d\vec{l}$

Força

- $\vec{F} = q\vec{E} = \frac{q_1 q_2}{4\pi\varepsilon_0} \frac{1}{r^2} \, N$

Trabalho

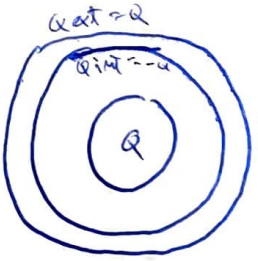
- $W = \int_A^B \vec{F} \, d\vec{l} = \int_A^B \frac{QQ'}{4\pi\varepsilon_0} \frac{1}{r^2} dr = \frac{QQ'}{4\pi\varepsilon_0} \left[-\frac{1}{r} \right]_{r=A}^{r=B} =$

$$= \frac{QQ'}{4\pi\varepsilon_0} \left(\frac{1}{r_A} - \frac{1}{r_B} \right) = Q \times V_{AB}$$

- $\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$

Carga superficial condutor esférico

(1) $\int \vec{E} \cdot \vec{n} \, ds = \frac{Q_S}{\varepsilon_0} \Rightarrow E_S^{=0} = \frac{Q_S}{\varepsilon_0} \Rightarrow Q_S = 0$



(2) $Q_S = Q_{int} + Q$

$Q_{int} = -Q$

(3) $Q_T = Q_{int} + Q_{ext}$

$Q_{ext} = -Q_{int} = Q$

Condensador Plano

① $V = \int_0^d \vec{E} \cdot \vec{dl} = E \int_0^d dl = Ed$

$V = Ed \Rightarrow E = \frac{V}{d}$

② $\int \vec{E} \cdot \vec{n}\, ds = \frac{Q}{\varepsilon_0} \Rightarrow$

$\Rightarrow E S = \frac{\sigma S}{\varepsilon_0} \Rightarrow$

$\Rightarrow E = \frac{\sigma}{\varepsilon_0}$

③ $E = \frac{\sigma}{\varepsilon_0} \Rightarrow E = \frac{Q}{\varepsilon_0 A}$

$\frac{Q}{\varepsilon_0 A} = \frac{V}{d} \Rightarrow$

$\Rightarrow V = A \varepsilon_0 \frac{V}{d}$

④ $Q = CV \Rightarrow \boxed{C = \frac{A \varepsilon_0 V}{dV} = \varepsilon_0 \frac{A}{d}}$

Condensador Esférico

① $\int \vec{E} \cdot \vec{n}\, ds = \frac{Q}{\varepsilon_0} \Rightarrow E S = \frac{Q}{\varepsilon_0} \Rightarrow E = \frac{Q}{\varepsilon_0 4\pi r^2}$

② $V = \int \vec{E}\, ds = \int_a^b \frac{Q}{4\pi\varepsilon_0} \frac{1}{r^2} dr =$

$= \frac{Q}{4\pi\varepsilon_0} \left[-\frac{1}{r} \right]_a^b =$

$= \frac{Q}{4\pi\varepsilon_0} \left(-\frac{1}{b} + \frac{1}{a} \right) =$

$= \frac{Q}{4\pi\varepsilon_0} \left(\frac{b-a}{ba} \right)$

③ $Q = CV \Rightarrow C = \frac{Q}{V} \Rightarrow \boxed{C = 4\pi\varepsilon_0 \frac{ab}{b-a}}$

Condensador Esférico

(1) $\int \vec{E}\cdot\vec{n}\,ds = \frac{Q}{\varepsilon} \Rightarrow ES = \frac{Q}{\varepsilon} \Rightarrow E = \frac{Q}{2\pi r L \varepsilon}$

(2) $V = \int \vec{E}\cdot d\vec{l} = \int_a^b \frac{Q}{2\pi r L\varepsilon}\,dr = \frac{Q}{2\pi L\varepsilon}\int_a^b \frac{1}{r}\,dr =$

$= \frac{Q}{2\pi L\varepsilon}\left[\ln r\right]_{r=a}^{r=b} = \frac{Q}{2\pi L\varepsilon}\left(\ln b - \ln a\right) = \frac{Q}{2\pi L\varepsilon}\ln\left(\frac{b}{a}\right)$

(3) $Q = CV \Rightarrow C = \frac{Q}{V} \Rightarrow C = \frac{Q\,2\pi L\varepsilon}{Q\ln\left(\frac{b}{a}\right)} \Rightarrow \boxed{C = \frac{2\pi L\varepsilon}{\ln\left(\frac{b}{a}\right)}}$

$$I = \frac{dq}{dt} = \Delta q$$

- $\Delta q = N q \Rightarrow N = \frac{\Delta q}{q} = \frac{I}{q}$

- $I = \int_S \vec{J} \cdot \vec{n}\, ds$

- $\vec{J} = \rho \vec{v}$

J - densidade de corrente elétrica.
v - velocidade de deriva.

- $\vec{J} = \sigma_c \vec{E}$

Resistência Elétrica

① $V = \int_0^L \vec{E} \cdot d\vec{l} = \int_0^L E\, dx = E \int_0^L dx = EL$

② $I = \int_S \vec{J} \cdot \vec{n}\, dS = \int_S J\, ds = J \int_S ds = JS$

③ $V = RI \Rightarrow R = \frac{V}{I} \Rightarrow R = \frac{EL}{JS} \Rightarrow \boxed{R = \frac{1}{\sigma_c}\frac{L}{S}}$

④ $J = \sigma_c E \Rightarrow \sigma_c = \frac{J}{E} \Rightarrow \frac{1}{\sigma_c} = \frac{E}{J}$

Potência

1. $P = \int JE\, dv = JE \int dv = JESl =$

$V = El$
$I = Js$

$= JSV = IV$

$V = RI$

2. $P = \frac{dw}{dt} =$

$= \frac{d}{dt}(qV) = IV$

$\boxed{P = IV}$

$\boxed{P = RI^2}$

h - densidade de potência $\quad \boxed{h = \frac{P}{V}}$