Física III → Eletromagnetismo

Cap 21

(Exercícios: 1, 2, 4, 7, 8, 14, 20, 27, 28)

Grécia – atração ímãs e Âmbar x Palha

Eletricidade — Magnetismo

1820 Eletromagnetismo (Oersted)

↓

1861 → Maxwell → Equações de Maxwell sumariza as leis do eletromagnetismo.

- Cargas elétricas → estão presentes em todos os materiais

→ cargas positivas (p) e cargas negativas (e)

- Carga quantizada elétrons prótons

. se # e = # p ⇒ neutro $q = 0$

. se # e ≠ # p ⇒ eletricamente carregado

$$q = \#p - \#e$$

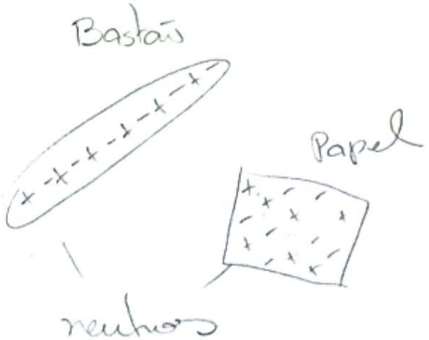
se $\#p > \#e \Rightarrow q > 0$

se $\#e > \#p \Rightarrow q < 0$

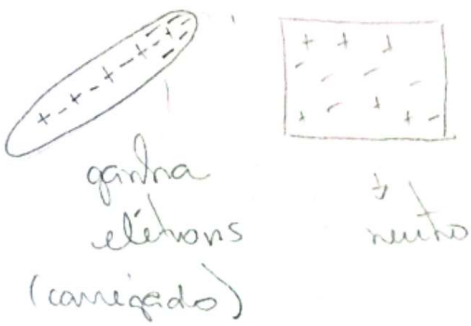
Carga elementar

$e = 1{,}6 \cdot 10^{-19} C$

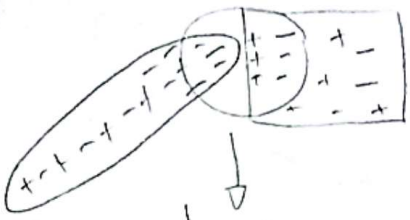
Millikan 1868



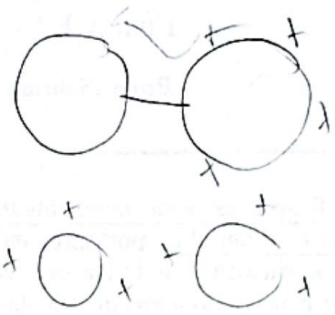
→ Atritar o bastão



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atração eletrostática

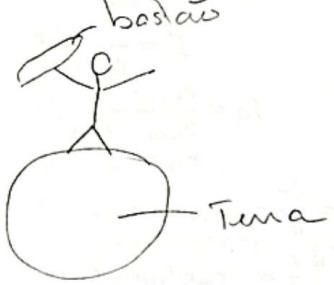


A carga se conserva

Condutores x Isolantes

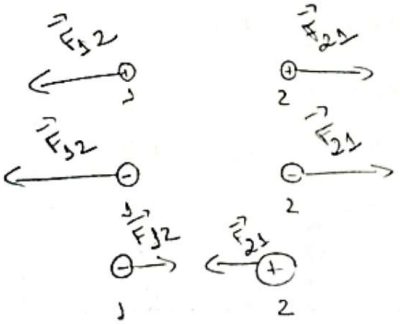
- Condutores: metais; água com impurezas
- Isolantes: borracha, vidro, plástico, H_2O (água pura)

• Discutir pq o experimento acima não funciona com um bastão metálico.



Os 3 elementos são condutores.

Lei de Coulomb (1785)



$$\vec{F} = k \frac{q_1 q_2}{r_2} \hat{r}$$

$\hat{r}$ direção que une as partículas

$\vec{F}_{12}$ e $\vec{F}_{21}$ não são um par de ação - reação

$[q] = C$ → coulomb

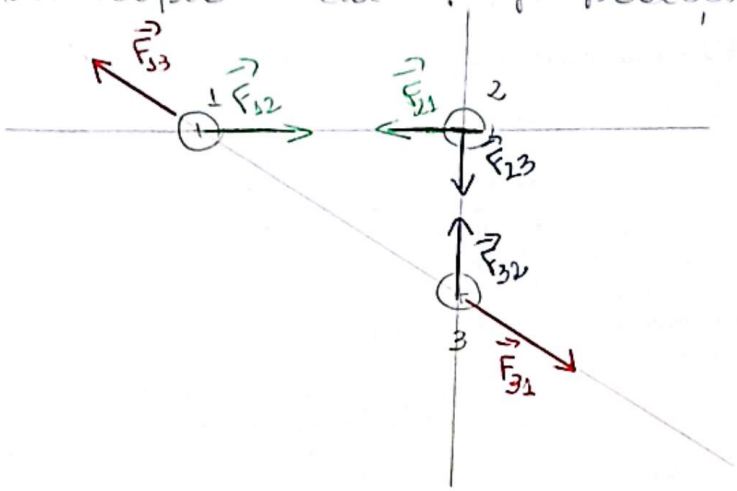
$[F] = N$

$$k = \frac{1}{4\pi\varepsilon_0} = 8{,}99 \times 10^9 \ N \cdot m^2/C^2$$

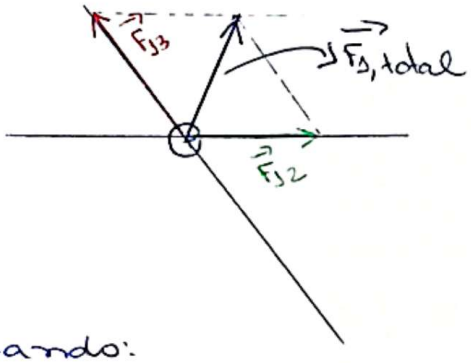
$$\approx 9 \cdot 10^9 \ N \cdot m^2/C^2$$

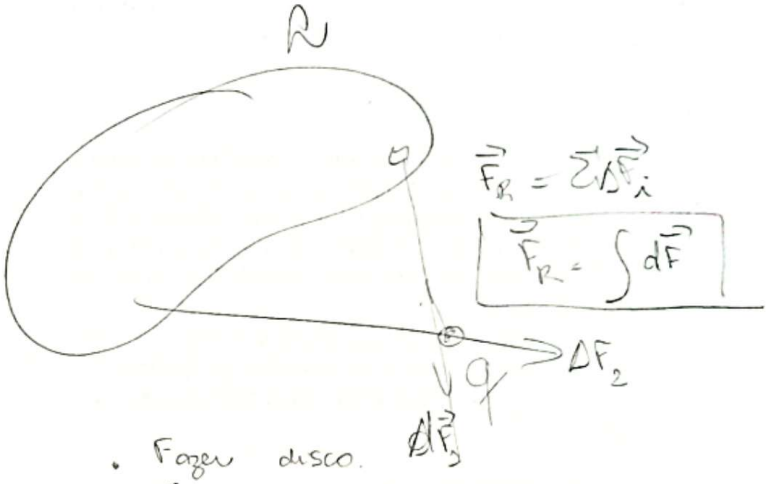
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Princípio da Superposição



$$\vec{F}_{1,total} = \vec{F}_{1,2} + \vec{F}_{13}$$



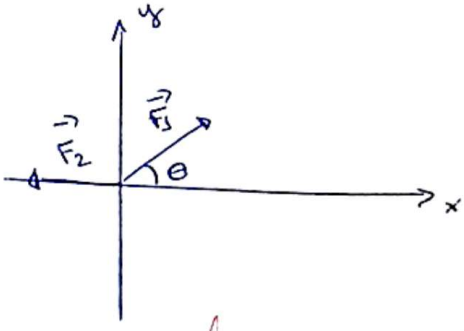


Lembrando: notação de vetores unitários. Teorema das cascas. Fazer disco.

$$\vec{F}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$$

$$\vec{F}_2 = a_2\hat{i} + b_2\hat{j} + c_3\hat{k}$$

$$\vec{F}_{Total} = \vec{F}_1 + \vec{F}_2 = (a_1 + a_2)\hat{i} + (b_1 + b_2)\hat{j} + (c_1 + c_2)\hat{k}$$



$$\vec{F}_1 = |\vec{F}_1|\cos\theta\,\hat{i} + |\vec{F}_1|\,\text{sen}\,\theta\,\hat{j}$$

$$\vec{F}_2 = -|\vec{F}_2|\,\hat{i}$$

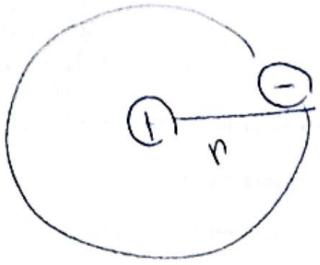
$$\Rightarrow \vec{F}_{total} = \left(|\vec{F}_1|\cos\theta - |\vec{F}_2|\right)\hat{i} + |\vec{F}_1|\,\text{sen}\,\theta\,\hat{j}$$

→ Condutores.

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Lei de

Átomo de Hidrogênio



$q_e = q_p = 1,6 \cdot 10^{-19} C$

$r \sim 5 \cdot 10^{-11} m$

$E_e = \frac{k|q_1||q_2|}{r_{12}^2}$

b)

$m_e = 9,1 \cdot 10^{-31} kg$

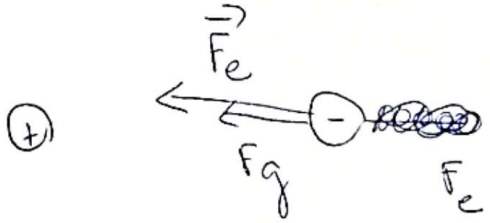
$m_p = 1,67 \cdot 10^{-27} kg$

$G \simeq 6,67 \times 10^{-11} N \cdot m^2/kg^2$

$K = 9 \cdot 10^9 \ N \cdot m^2/C^2$

$F_e \sim 8 \cdot 10^{-8} N$

$F_g \sim 3,6 \times 10^{-47} N$

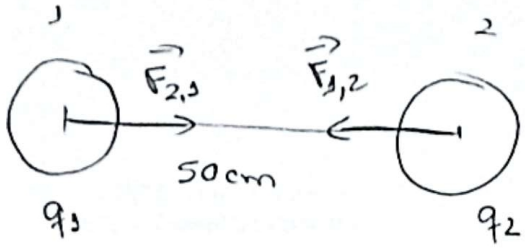


$F_g \ll F_e \Rightarrow$ desprezamos.

$F_R = m a_{LD}$ aceleração centrípeta.

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9)



Antes $F_{antes} = 0,108\ N$



$F_{depois} = 0,036\ N$

Conservação de carga:

$$q_1 + q_2 = q_1' + q_2' \quad (1)$$

$$q_1' = q_2' \quad (2)$$

$$|F_{antes}| = \frac{k|q_1||q_2|}{r^2} = -k\frac{q_1 q_2}{r^2} \quad (3)$$

$$|F_{depois}| = \frac{k q_1'^2}{r^2}$$

$$0,108 = -k\frac{q_1 q_2}{0,5^2} \quad (3) \Rightarrow q_1 q_2 = \frac{108.10^{-3}.25.10^{-2}}{9.10^9} = 3.10^{-10}\ C^2$$

$$0,036 = \frac{k q_1'^2}{0,5^2} \quad (4) \Rightarrow q_1'^2 = \frac{36.10^{-3}.25.10^{-2}}{9.10^9} = \frac{36.10^{-3}}{4.9.10^9} = 10^{-12}$$

$(2) \rightarrow (1)$

$$2q_1' = q_1 + q_2$$

$$q_1' = \pm 10^{-6}\ C$$

$$2.10^{-6} = q_1 + \frac{3.10^{-12}}{q_1}$$

$$q_1 \cdot q_2 = 3.10^{-2}$$

$$q_1 2.10^{-6} = q_1^2 - 3.10^{-12}$$

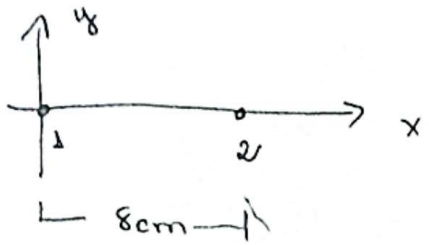
$$q_1^2 - 2q_1.10^{-6} - 3.10^{-12} = 0$$

$$q_1 = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{2.10^{-6} \pm \sqrt{4.10^{-12} + 12.10^{-12}}}{2}$$

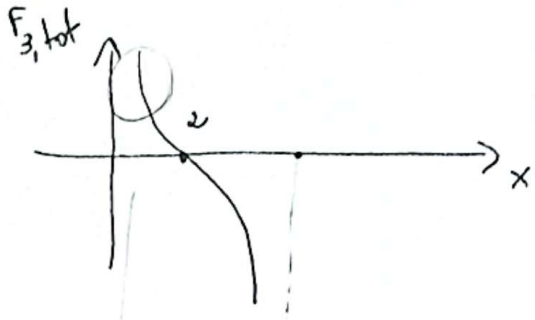
$$= \frac{2.10^{-6} \pm 4.10^{-6}}{2} = \begin{cases} 3.10^{-6}\ C \\ -1.10^{-6}\ C \end{cases}$$

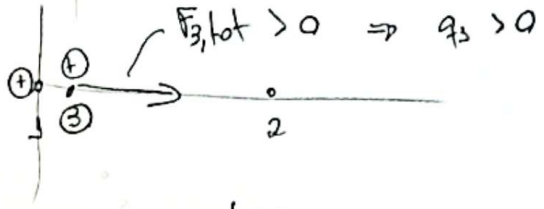
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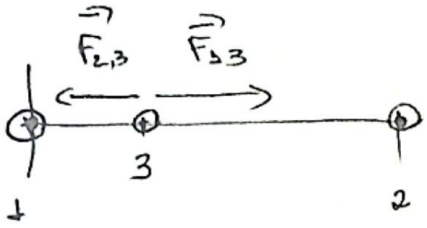
16)

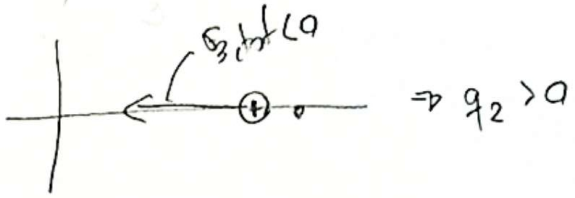


$q_3 = 8 \cdot 10^{-19}\ C$









$$\vec{F}_{R,3} = \vec{F}_{2,3} + \vec{F}_{1,3}$$

$$F_{R3} = F_{13} - F_{23}$$

$$0 = \frac{k q_1 q_3}{(2 \cdot 10^{-2})^2} - \frac{k q_2 q_3}{(6 \cdot 10^{-2})^2} \qquad \frac{q_1}{4 \cdot 10^{-4}} = \frac{q_2}{36 \cdot 10^{-4}}$$

$$\boxed{\frac{q_2}{q_3} = +9}$$

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