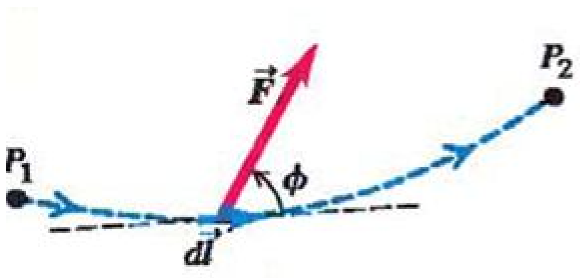
Fisica II: Energía Potencial

Profesora : Dra. Elsa Hogert

- **Bibliografía consultada: Sears- Zemasnky -Tomo II**
  Serway- Jewett – Tomo II

ENERGÍA POTENCIAL- POTENCIAL ELECTROSTÁTICO

REPASO



$$W = \int_{P_1}^{P_2} F\cos\phi \, dl = \int_{P_1}^{P_2} F_{\parallel} \, dl = \int_{P_1}^{P_2} \vec{F} \cdot d\vec{l}$$

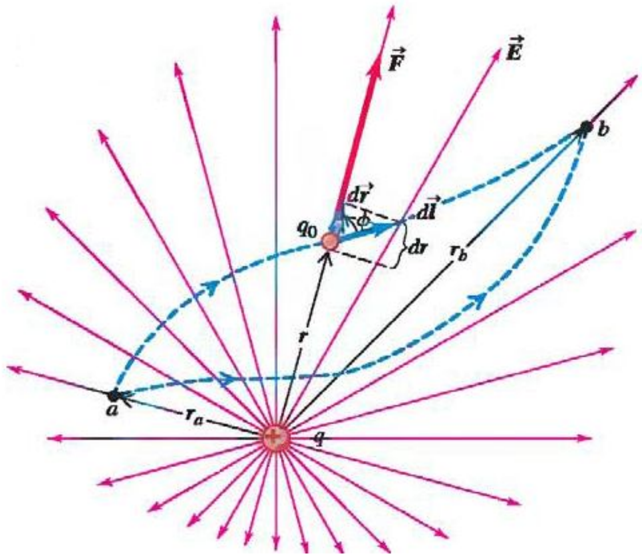
$$|\mathbf{w}| = \mathbf{N.m} = \mathbf{Joule} = \mathbf{J}$$

Si **F** es conservativa ⟹ **W** no depende de la trayectoria, sino de la posición inicial y final

1) $$\mathbf{W} = \int \vec{\mathbf{F}}.\mathbf{d}\vec{\mathbf{l}} = -\Delta\mathbf{U}$$

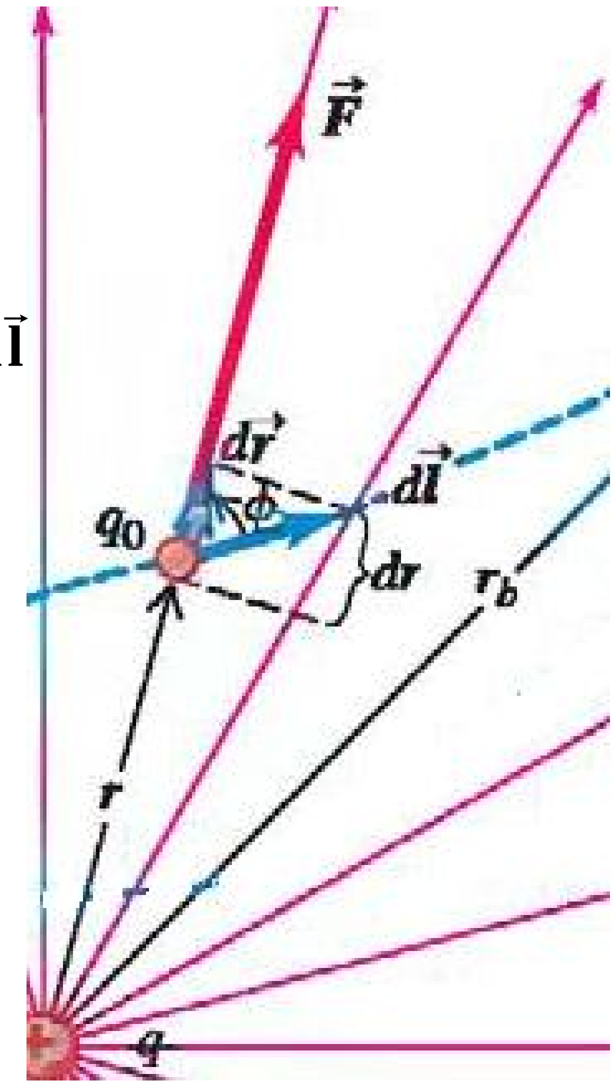
2) $$\Delta\mathbf{K} = \mathbf{W}_{\mathbf{Fc}} + \mathbf{W}_{\mathbf{Fnc}}$$

W REALIZADO POR F ELECTROSTÁTICA



$$\vec{E}(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$$

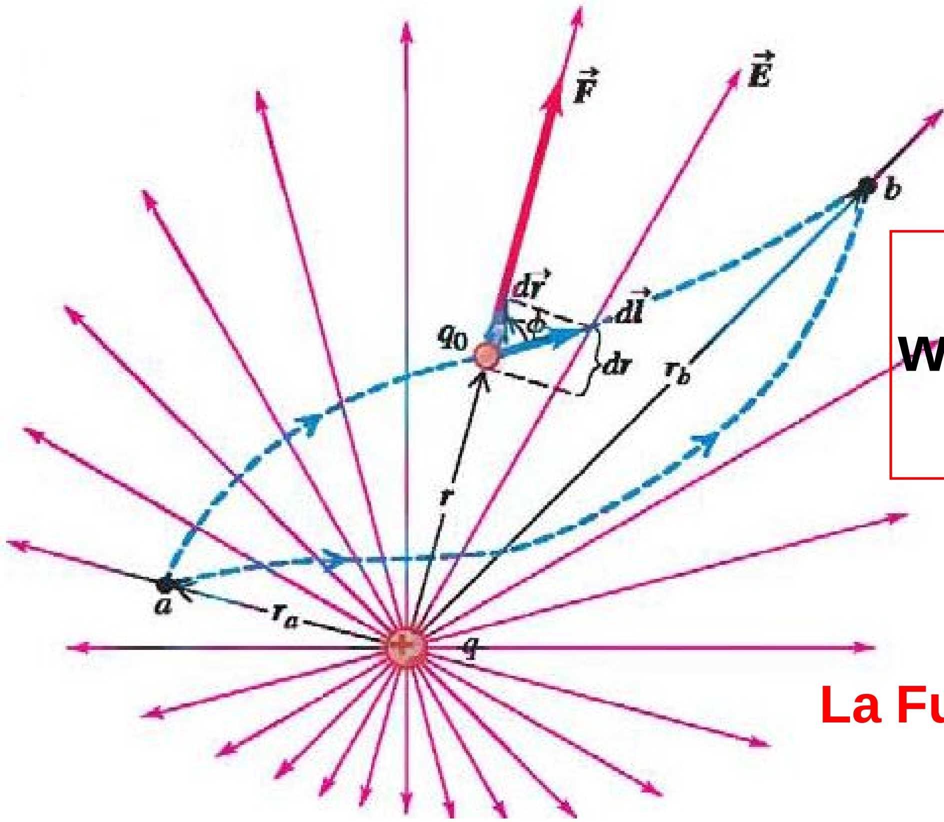
$$w_{a\to b} = \int_{r_a}^{r_b} \vec{F}.d\vec{l} = \int_{r_a}^{r_b} q_0\,\vec{E}.d\vec{l}$$



$$w_{a\to b} = q_0\int_{r_a}^{r_b} \vec{E}.d\vec{l} = \frac{q_0 q}{4\pi\varepsilon_0}\int_{r_a}^{r_b}\frac{\hat{r}}{r^2}.d\vec{l} = \frac{q_0 q}{4\pi\varepsilon_0}\int_{r_a}^{r_b}\frac{\cos\phi\, dl}{r^2}$$

$$\cos\phi\, dl = dr$$

$$w_{a\to b} = \frac{q_0 q}{4\pi\varepsilon_0}\int_{r_a}^{r_b}\frac{dr}{r^2} = \frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right)$$

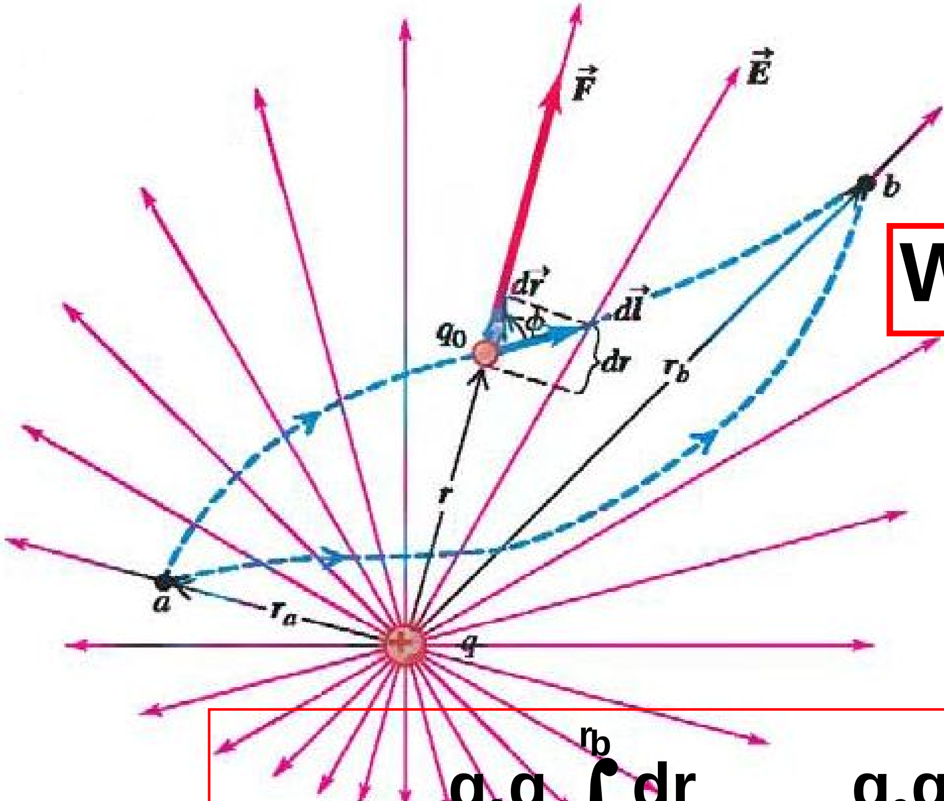


$$W_{a\to b} = \frac{q_0 q}{4\pi\varepsilon_0}\int_{r_a}^{r_b}\frac{dr}{r^2} = -\frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{r_b}-\frac{1}{r_a}\right)$$

La Fuerza electrostática es conservativa

$$\oint \vec{F}.d\vec{l} = 0$$

$$\oint q\vec{E}.d\vec{l} = 0 \Rightarrow \oint \vec{E}.d\vec{l} = 0$$



$$W_{a\to b} = -(U_b - U_a) = -\Delta U$$

$$W_{a\to b} = \frac{q_0 q}{4\pi\varepsilon_0}\int_{r_a}^{r_b}\frac{dr}{r^2} = -\frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{r_b}-\frac{1}{r_a}\right) = -(U_b - U_a) = -\Delta U$$

$$\frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{r_b}-\frac{1}{r_a}\right) = (U_b - U_a) = \Delta U$$

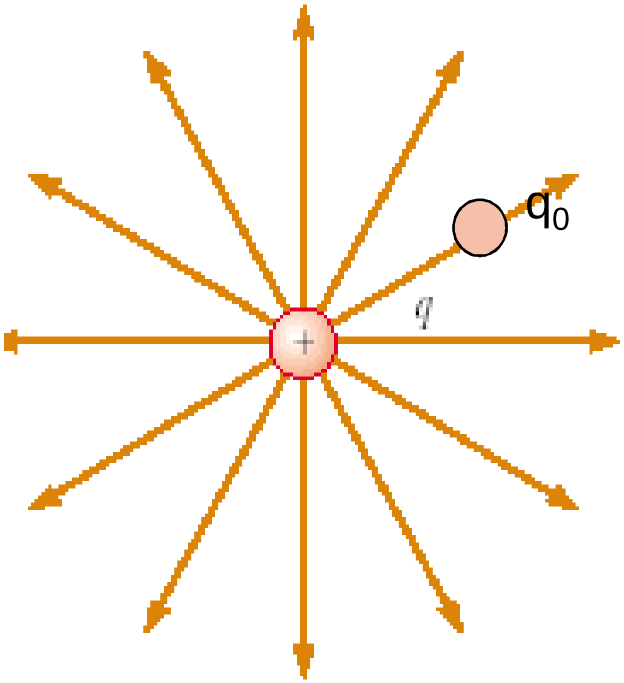
VARIACIÓN DE ENERGÍA POTENCIAL

1. **U** es siempre definida respecto de un punto donde **U=0 arbitrario**

2. **ΔU**

3. **U** es una propiedad compartida entre las 2 cargas - consecuencia de la interacción entre ellas.

W realizado para traer q_0 desde el infinito hasta r



$$W_{\infty \to r} = -\frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{r} - \frac{1}{\infty}\right) = -\frac{q_0 q}{4\pi\varepsilon_0}\frac{1}{r}$$

$$\frac{q_0 q}{4\pi\varepsilon_0}\frac{1}{r} = (U_b - U_a) = \Delta U$$

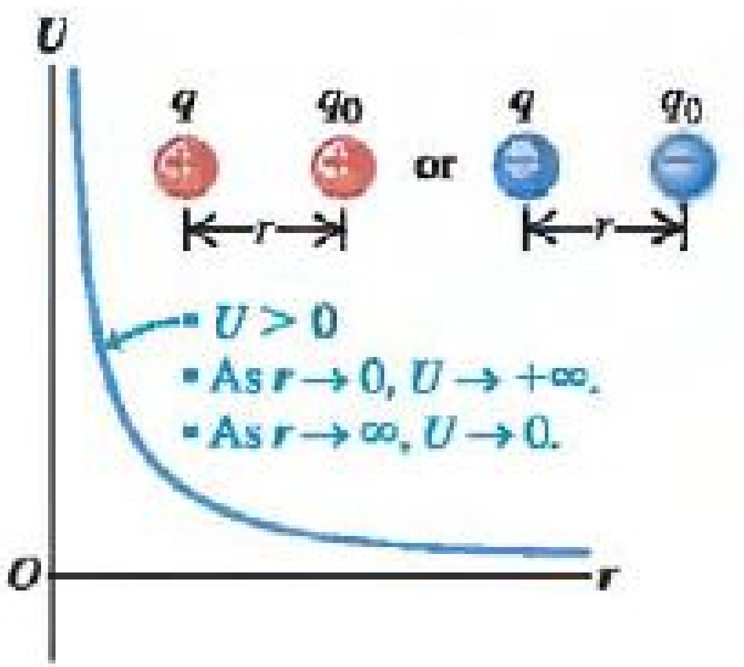
Se puede considerar U=0 en el infinito

$$\frac{q_0 q}{4\pi\varepsilon_0}\frac{1}{r} = U(r)$$

$$\frac{q_0 q}{4\pi\varepsilon_0}\frac{1}{r} = U(r) = -W_{\infty\to r}$$

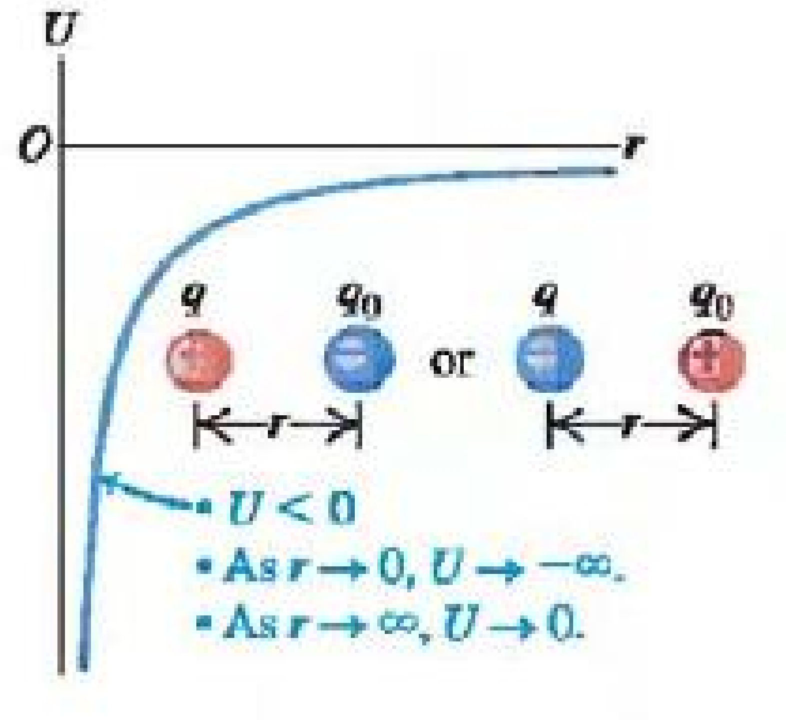
Si signo q =signo q_0

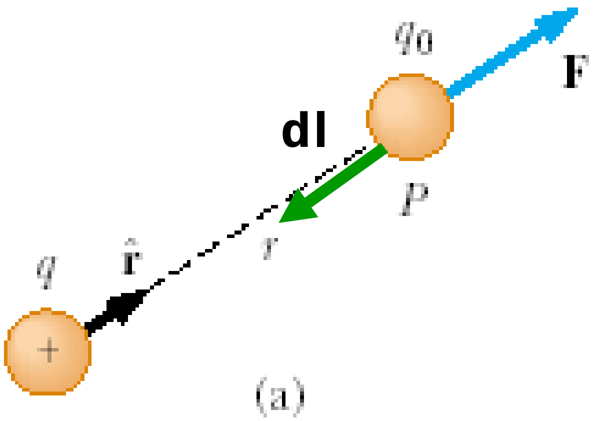
$$W_{\infty\to r} < 0 \Rightarrow \Delta U > 0$$



Si signo q ≠signo q_0

$$W_{\infty\to r} > 0 \Rightarrow \Delta U < 0$$





Debe existir un $\mathbf{F}_{ext}$, que realiza un $\mathbf{W}_{ext}$

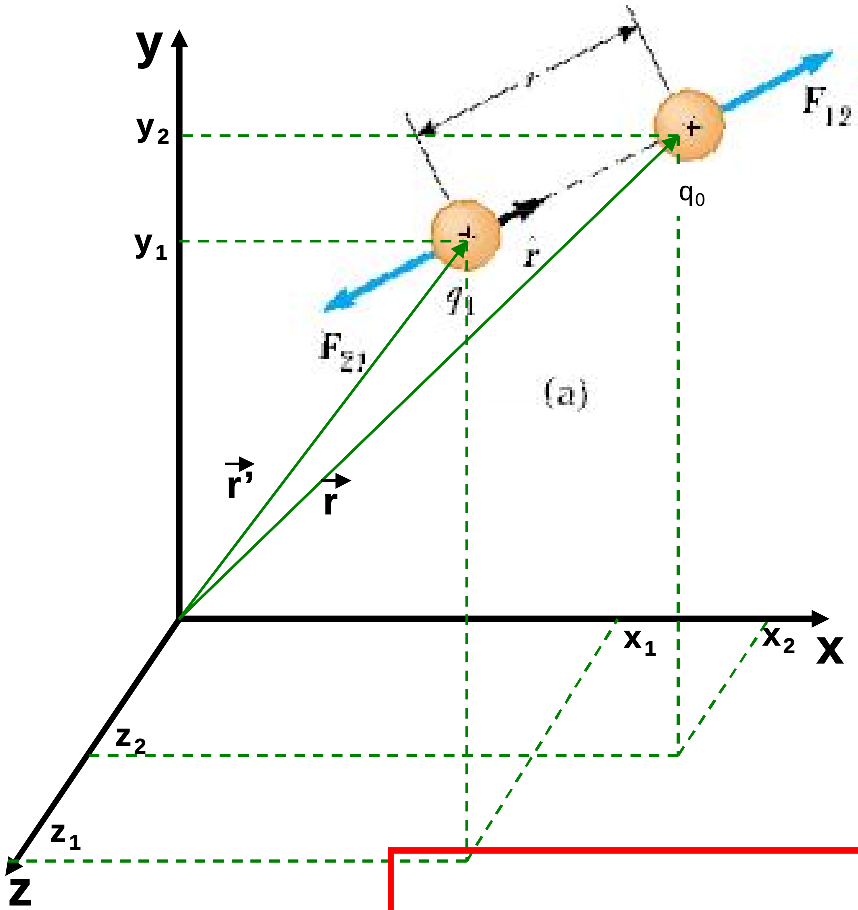
electrostática $\Rightarrow \mathbf{v} = \mathbf{cte} \Rightarrow \mathbf{a} = \mathbf{0} \Rightarrow \sum \vec{\mathbf{F}} = \mathbf{0}$

$$\vec{\mathbf{F}}_{ext} = -\vec{\mathbf{F}}_{elec}$$

$$\Delta \mathbf{K} = \mathbf{0}$$

Cuando las **Q** igual signo, $\mathbf{F}_{ext}$ realiza un $\mathbf{W > 0}$

Si q no está en el origen de coordenas

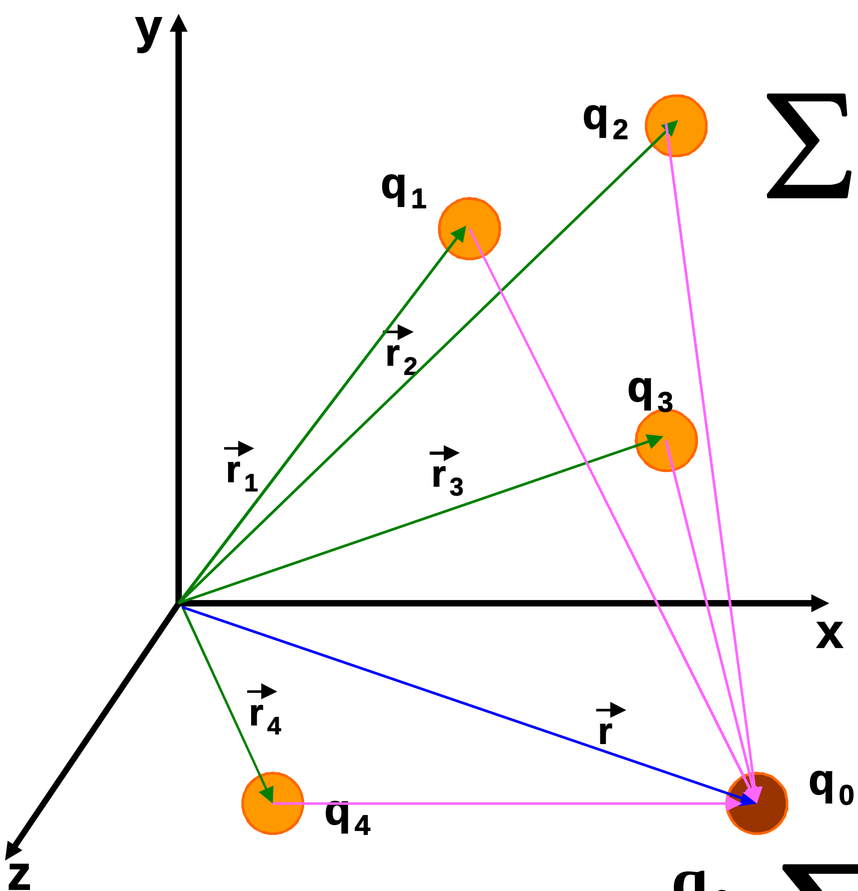


$$\frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{r_b}-\frac{1}{r_a}\right)=(U_b-U_a)=\Delta U$$

$$\frac{1}{r_{b,a}}=\frac{1}{\left|\vec{r}_{b,a}-\vec{r}\,'\right|}$$

$$\Delta U=(U_b-U_a)=\frac{q_0 q}{4\pi\varepsilon_0}\left(\frac{1}{\left|\vec{r}_b-\vec{r}\,'\right|}-\frac{1}{\left|\vec{r}_a-\vec{r}\,'\right|}\right)=-W_{a\to b}$$

UN SISTEMA DE CARGAS



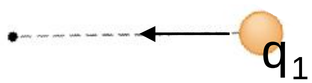
Por principio de superposición

$$\sum \frac{q_0 q_i}{4\pi\varepsilon_0}\left(\frac{1}{\left|\vec{r}_b - \vec{r}_i\,'\right|} - \frac{1}{\left|\vec{r}_a - \vec{r}_i\,'\right|}\right) = (U_b - U_a) = \Delta U$$

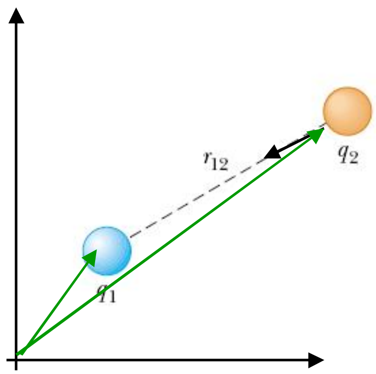
$$r_a \to \infty$$

$$\frac{q_0}{4\pi\varepsilon_0}\sum q_i\left(\frac{1}{\left|\vec{r}_b - \vec{r}_i\,'\right|}\right) = (U_b - U_a) = U$$

ENERGIA POTENCIAL ALMACENADA EN UN SIST. DE CARGAS DE CARGAS

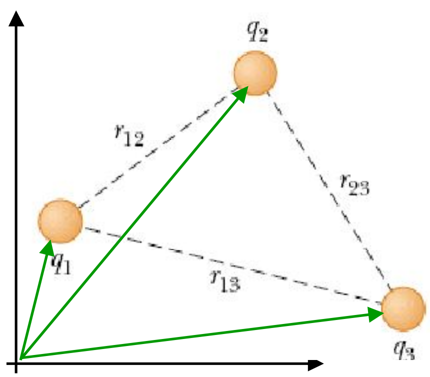


$$U_1 = 0$$

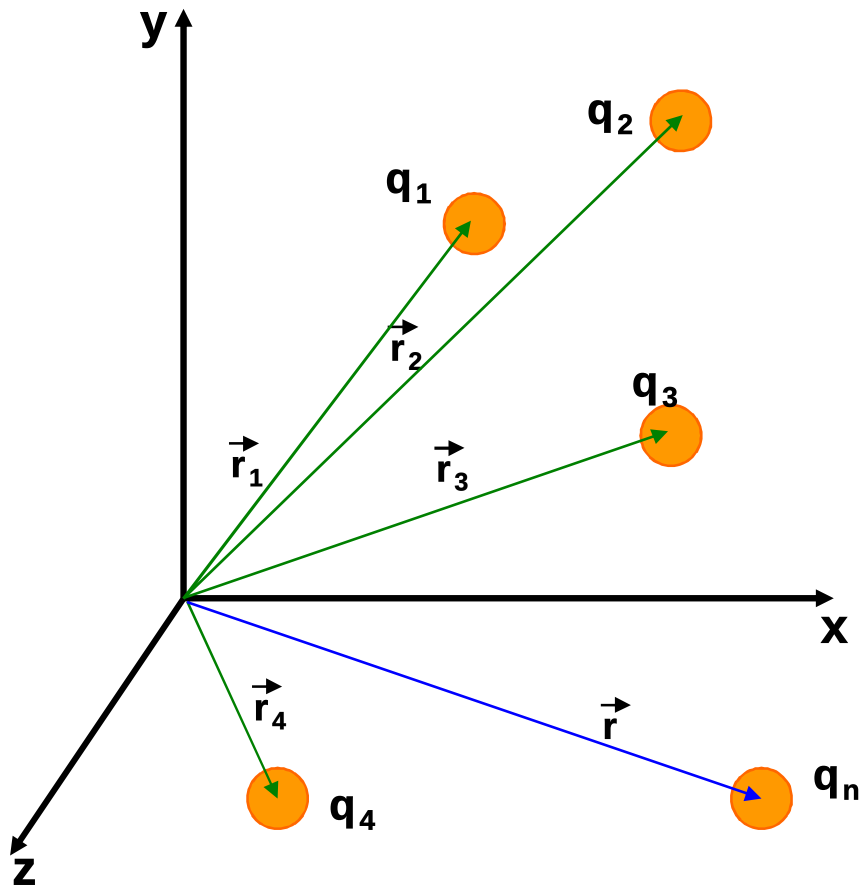


$$U_2(r) = \frac{q_1 q_2}{4\pi\varepsilon_0} \frac{1}{|r_2 - r_1|} = \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$$

$$U_3(r) = \frac{q_1 q_3}{4\pi\varepsilon_0 r_{13}} + \frac{q_2 q_3}{4\pi\varepsilon_0 r_{23}}$$



$$U(r) = \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}} + \frac{q_1 q_3}{4\pi\varepsilon_0 r_{13}} + \frac{q_2 q_3}{4\pi\varepsilon_0 r_{23}}$$



$$U = \sum_{\substack{i<j \\ i \neq j}} \frac{q_i q_j}{4\pi\varepsilon_0 r_{ij}}$$