# Electric Potential Energy of Two Point Charges

Consider two different perspectives:

#1a Electric potential when $q_1$ is placed: $V(\vec{r}_2) \doteq V_2 = k\dfrac{q_1}{r_{12}}$

Electric potential energy when $q_2$ is placed into potential $V_2$: $U = q_2 V_2 = k\dfrac{q_1 q_2}{r_{12}}$

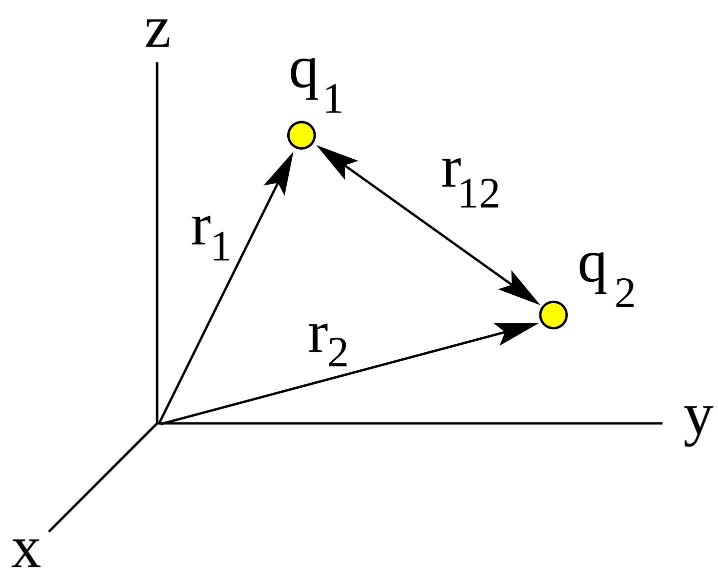
#1b Electric potential when $q_2$ is placed: $V(\vec{r}_1) \doteq V_1 = k\dfrac{q_2}{r_{12}}$

Electric potential energy when $q_1$ is placed into potential $V_1$: $U = q_1 V_1 = k\dfrac{q_1 q_2}{r_{12}}.$

#2 Electric potential energy of $q_1$ and $q_2$:

$$U = \frac{1}{2}\sum_{i=1}^{2} q_i V_i,$$

where $V_1 = k\dfrac{q_2}{r_{12}}, \quad V_2 = k\dfrac{q_1}{r_{12}}.$



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#1 Place $q_1$, then $q_2$, then $q_3$, and add all changes in potential energy:

$$U = 0 + k\frac{q_1q_2}{r_{12}} + k\left(\frac{q_1q_3}{r_{13}} + \frac{q_2q_3}{r_{23}}\right) = k\left(\frac{q_1q_2}{r_{12}} + \frac{q_1q_3}{r_{13}} + \frac{q_2q_3}{r_{23}}\right).$$

#2 Symmetric expression of potential energy $U$ in terms of the potentials $V_i$ experienced by point charges $q_1$:

$$U = \frac{1}{2}\sum_{i=1}^{3} q_iV_i = k\left(\frac{q_1q_2}{r_{12}} + \frac{q_1q_3}{r_{13}} + \frac{q_2q_3}{r_{23}}\right),$$

where

$$V_1 = k\left(\frac{q_2}{r_{12}} + \frac{q_3}{r_{13}}\right),$$

$$V_2 = k\left(\frac{q_1}{r_{12}} + \frac{q_3}{r_{23}}\right),$$

$$V_3 = k\left(\frac{q_1}{r_{13}} + \frac{q_2}{r_{23}}\right).$$