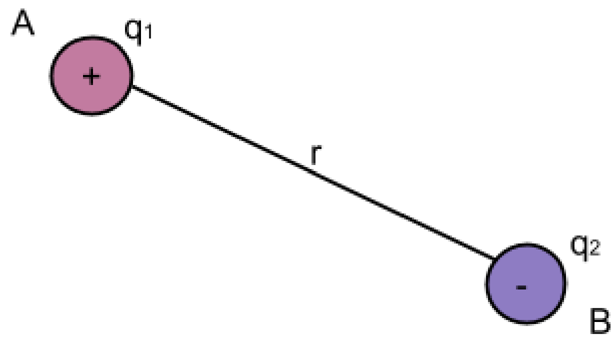
Potential Easy Example (potential energy of charges)

Calculate the change in potential energy due to bringing 2 charges of opposite signs from infinity to the positions illustrated in the diagram:



<u>Solution</u>

Step 1: Relate potential energy of the system to the electric potential: $\Delta U = q\Delta V$

$$\Delta U = \Delta U_{q1} + \Delta U_{q2}$$

Step 2: Calculate the change in potential energy of bringing in q_1 from infinity to point A, assuming the other charge, q_2 stays at infinity.

$$\Delta U_{q1} = q_1 \Delta V_{\infty \to A}$$

But, since $V_\infty = 0$ and $V_A = 0$ (because there is no electric field from any source):

$$\Delta V_{\infty \to A} = V_A - V_\infty = 0 - 0 = 0V$$

Therefore: $\Delta U_{q1} = 0$

Step 3: Calculate the change in potential energy of bringing in q_2 from infinity to point B.

$$\Delta U_{q2} = q_2 \Delta V_{\infty \to B}$$

where $V_\infty = 0$ again, but $V_B \neq 0$ because q_1 is in the same space and is producing an electric field that affects particle q_2: $V_B = \frac{kq_1}{r_{AB}}$

Hence: $\Delta U_{q2} = q_2(V_B - V_\infty) = \frac{kq_1q_2}{r_{AB}}$ where $r_{AB} = r$ is the final distance between the two particles.

Step 4: Add up the potential energies: $\Delta U = \Delta U_{q1} + \Delta U_{q2} = 0 + \frac{kq_1q_2}{r_{AB}} = \frac{kq_1q_2}{r_{AB}}$