$$W = \frac{\epsilon_0}{2} \int_V |E|^2 dV$$

$$= \frac{\epsilon_0}{2} \frac{1}{(4\pi\epsilon_0)^2} \cdot \int_0^{\infty} 4\pi \frac{q^2}{r^4} r^2 dr \cdot \longmapsto \text{diverges}$$

$$W = \frac{q_1 q_2}{4\pi\epsilon_0 |\vec{r}_1 - \vec{r}_2|}$$

$$W = \frac{q_1\, q_2 \cdot \epsilon_0}{16\pi^2 \epsilon_0^2} \int_{\text{Space}} \frac{(\vec{r}-\vec{r}_1)\cdot(\vec{r}-\vec{r}_2)}{|\vec{r}-\vec{r}_1|^3\, |\vec{r}-\vec{r}_2|^3}\, d^3 r \,.$$

$$\vec{R} = \frac{\vec{r}-\vec{r}_1}{|\vec{r}_1-\vec{r}_2|} \; ; \quad \vec{r}-\vec{r}_2 = |\vec{r}_1-\vec{r}_2|\vec{R} + (\vec{r}_1-\vec{r}_2)$$

$$W_{int} = \frac{q_1 q_2}{16\pi^2 \epsilon_0} \int \frac{[|\vec{r}_1-\vec{r}_2|\vec{R}]\cdot[|\vec{r}_1-\vec{r}_2|\vec{R} + (\vec{r}_1-\vec{r}_2)]}{R^3 \underbrace{|r_1-r_2|^3}_{|\vec{r}_1-r_2|^3} [|\vec{r}_1-\vec{r}_2|\vec{R} + (\vec{r}_1-\vec{r}_2)]^3} \frac{d^3 R}{\cancel{|\vec{r}_1-\vec{r}_2|^3}}$$

$$W_{int} = \frac{q_1 q_2}{16\pi^2\epsilon_0}\,\frac{1}{|\vec{r}_1-\vec{r}_2|}\int\left(-\nabla\frac{1}{|\vec{R}|}\right)\cdot\left(-\nabla\frac{1}{|\vec{R}+\hat{n}|}\right)d^3\vec{R}$$

$$\nabla f\cdot\nabla g = \nabla\cdot(f\nabla g) - f(\nabla^2 g)$$

$$f = \frac{1}{|\vec{R}+\hat{n}|}\ ;\ g = \frac{1}{|\vec{R}|}$$

$$\cancel{\int \nabla\cdot\underbrace{\left(\frac{1}{|\vec{R}+\hat{n}|}\nabla\frac{1}{|\vec{R}|}\right)}\,d^3r} - \int \underbrace{\frac{1}{|\vec{R}+\hat{n}|}\nabla^2\frac{1}{|\vec{R}|}}_{-4\pi\,\delta^3(\vec{R})}\,d^3R$$

$$\Downarrow$$

$$\frac{1}{|\hat{n}|} = 1 \checkmark \ (-4\pi)$$

$$\underbrace{\frac{q}{|\vec{r}-\vec{r}_1|}}_{\vec{r}\neq\vec{r}_1} \rightarrow \int \frac{\rho\, d^3r}{|\vec{r}-\vec{r}_1|}$$

$$\vec{E} = 0 \qquad \vec{\nabla} \cdot \vec{E} = 0 = \frac{\rho}{\epsilon_0}$$

$$\rho \to 0$$

$$\Delta V = -\int_A^B \underline{\underline{\vec{E} \cdot \vec{dl}}} = 0 \qquad \vec{E} \perp \vec{dl}$$