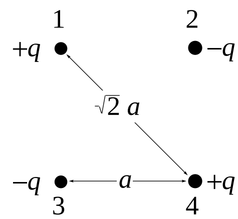
Electric potential energy



The potential energy belongs to the pairs of particles — to the "bonds" — not to the individual particles. Hence we must sum over the pairs rather than summing over the particles.

$$\begin{aligned} U_{12} = U_{13} = U_{24} = U_{34} &= \frac{1}{4\pi\epsilon_0}\left(-\frac{q^2}{a}\right) \\ U_{14} = U_{23} &= \frac{1}{4\pi\epsilon_0}\left(\frac{q^2}{\sqrt{2}\,a}\right) \\ \text{so the total electric P.E. is} \quad U &= (-4+\sqrt{2})\frac{1}{4\pi\epsilon_0}\frac{q^2}{a}. \end{aligned}$$

This energy is negative. That is, there is less electric potential energy in this configuration than in the four particles being infinitely far apart.

Grading: Use the general idea that any startup is valuable. There's no need for the final remark about negative energy. I put it in just to battle the misconception propagated by *Star Trek: The Original Series* in the episode "By Any Other Name".