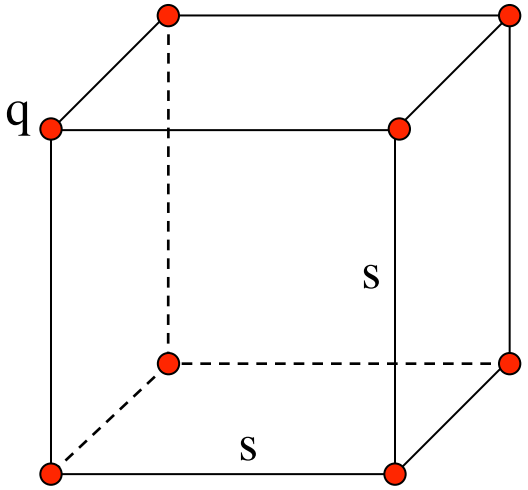
Problem 25.29

How much energy is required to assemble the charge configuration shown to the right, assuming all the charges are the same and the structure is a perfect square of side "s."



We could do this the way we did Problem 25.22, but there is a more economical way as there is a lot of symmetry to this situation. Counting, we find that there are 12 diagonals of length $s\sqrt{2}$ and 12 sides of length *s*. There are additionally 4 interior diagonal pairs of length $s\sqrt{3}$. As electrical potential energy is a scalar quantity, and as each charge combination contributes, we can use the same reasoning utilized in Problem 25.22 and write:

$$U_{total} = 12q\left(k\frac{q}{s}\right) + 12q\left(k\frac{q}{s\sqrt{2}}\right) + 4q\left(k\frac{q}{s\sqrt{3}}\right)$$

$$= k\frac{q^2}{s}\left[12 + \frac{12}{\sqrt{2}} + \frac{12}{\sqrt{3}}\right]$$

$$= 22.8k\frac{q^2}{s}$$