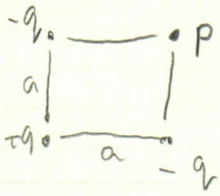
2.31



a) $V_P = \frac{1}{4\pi\varepsilon_0}\left(\frac{-q}{a}+\frac{-q}{a}+\frac{q}{\sqrt{2}a}\right) = \frac{q}{4\pi\varepsilon_0 a}\left(\frac{\sqrt{2}}{2}+\frac{4}{2}\right) = \frac{q}{4\pi\varepsilon_0}\left(\frac{\sqrt{2}-4}{2}\right)$

$V_P = \frac{q}{8\pi\varepsilon_0}(\sqrt{2}-4)$; $W = qV_P = \frac{q^2}{8\pi\varepsilon_0}(\sqrt{2}-4)$

b) Starting w/ point P, let's consider each charge in counterclockwise order.

1. $W_1 = 0$

2. $W_2 = -V_2 q = -q\left(k\frac{q}{a}\right) = \frac{kq^2}{a}\left(\frac{-2}{2}\right)$

3. $W_3 = V_3 q = q\left(-\frac{kq}{a}+\frac{kq}{\sqrt{2}a}\right) = \frac{kq^2}{a}\left(\frac{\sqrt{2}-2}{2}\right)$

4. $W_4 = -V_4 q = -qk\left(\frac{q}{a}+\frac{-q}{\sqrt{2}a}+\frac{q}{a}\right) = \frac{kq^2}{a}\left(\frac{\sqrt{2}-4}{2}\right)$

$W_{Total} = \sum_{i=1}^{4} W_i = \frac{kq^2}{2a}\left(-2+\sqrt{2}-2+\sqrt{2}-4\right) = \frac{kq^2}{2a}2(\sqrt{2}-4)$

$W_{Total} = \frac{q^2}{4\pi\varepsilon_0 a}(\sqrt{2}-4)$

b) (alternative method)

$W = \frac{k}{2}\sum_{i=1}^{4}\left(\sum_{j\neq i}^{n}\frac{q_j}{r_{ij}}\right) = \frac{k}{2}\left(\frac{-q^2}{a}+\frac{q^2}{\sqrt{2}a}+\frac{-q^2}{a}+\frac{-q^2}{a}+\frac{-q^2}{a}+\frac{q^2}{\sqrt{2}a}+\frac{-q^2}{a}+\frac{-q^2}{a}+\frac{q^2}{\sqrt{2}a}\right.$
$\left.+\frac{-q^2}{a}+\frac{-q^2}{a}+\frac{q^2}{\sqrt{2}a}\right) = \frac{4k}{2}\left(\frac{-2q^2}{a}+\frac{q^2}{\sqrt{2}}\right)$

$W = \frac{q^2}{2\pi\varepsilon_0 a}\left(\frac{1}{\sqrt{2}}-2\right) = \frac{q^2}{4\pi\varepsilon_0 a}(\sqrt{2}-4)$