5. $W = k\left(\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right)$

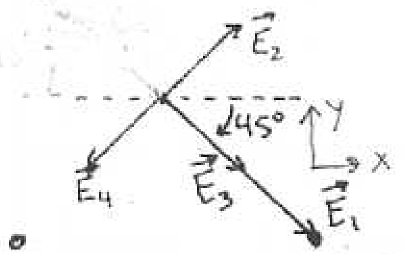
$= (8.99 \times 10^9 \ \frac{N \cdot m^2}{C^2})\left(\frac{(5.5\times10^{-6}C)(-6.5\times10^{-6}C)}{0.12\ m} + \frac{(5.5\times10^{-6}C)(2.5\times10^{-6}C)}{0.20m} + \frac{(-6.5\times10^{-6}C)(2.5\times10^{-6}C)}{0.16\ m}\right)$

$= (8.99\times10^{9} N\cdot m^2/C^2)(-2.98\times10^{-10}\ C^2/m + 6.88\times10^{-11}\ C^2/m$

$= (8.99\times10^{9} N\cdot m^2/C^2)(-3.31\times10^{-10}C^2/m - 1.02\times10^{-10}\ C^2/m)$

$= -\ 3.0\ J$

10. $+9.0\mu C\ (q_1)$ $-3.0\mu C\ (q_2)$



$-3.0\mu C\ (q_4)$ $-3.0\mu C\ (q_3)$

$E_1 = \frac{kq_1}{r_1^2} = \frac{(8.99\times10^9 N\cdot m^2/C^2)(9.0\times10^{-6}C)}{2.0\times10^{-4}m^2}$

$= 4.0\times10^8\ N/C$

$E_3 = \frac{(8.99\times10^9 N\cdot m^2/C^2)(3.0\times10^{-6}C)}{2.0\times10^{-4}m^2}$

$= 1.3\times10^8\ N/C$

$r_1^2 = r_2^2 = r_3^2 = r_4^2 = (0.010m^2 + 0.010m^2)$

$= 2.0\times10^{-4}m^2$

$\vec{E}_2$ and $\vec{E}_4$ are equal in magnitude and opposite in direction. They add to zero. $\vec{E}_1$ and $\vec{E}_3$ are in the same direction.

$E_{total} = |\vec{E}_1 + \vec{E}_3| = 5.3\times10^8\ N/C$

$\vec{E}_{total} = +5.3\times10^8\ N/C\ \cos 45°\ \hat{i} - 5.3\times10^8\ N/C\ \sin 45°\ \hat{j}$

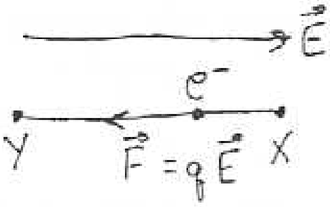
$= +3.7\times10^8\ N/C\ \hat{i} - 3.7\times10^8\ N/C\ \hat{j}$

or $5.3\times10^8\ N/C$ at 45° below the +X-axis

$V = k\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \frac{q_4}{r_4}\right) = 8.99\times10^9 N\cdot m^2/C^2\left(\frac{9.0\times10^{-6}C}{1.4\times10^{-2}m} + \frac{3(-3.0\times10^{-6}C)}{1.4\times10^{-2}m}\right)$

$= 0$ volts

23.



(a) Y is at the higher potential
(Think of a positive charge attracting an electron.)

(b) $V_y - V_x = \dfrac{8.0 \times 10^{-19}\ \text{J}}{1.602 \times 10^{-19}\ \text{C}} = 5.0\ \text{V}$

31. $\Delta V = V_p - V_s = 500.0\ \text{kV} - 200.0\ \text{kV} = 300.0\ \text{kV}$

$\Delta KE = q\,\Delta V = (+2e)(300.0 \times 10^3\ \text{V}) = 600.0 \times 10^3\ \text{eV}$

$= 6.000 \times 10^5\ \text{eV}$

$= (6.000 \times 10^5\ \text{eV})(1.602 \times 10^{-19}\ \text{J/eV})$

$= 9.612 \times 10^{-14}\ \text{J}$

97. $E = \frac{1}{2} C V^2$

$U_0 = \frac{1}{2} C_0 V^2$

$U = \frac{1}{2} \underbrace{\epsilon C_0}_{C} V^2 = \epsilon U_0 = 3 U_0$