80. (a) The charges are equal and are the same distance from C. We use the Pythagorean theorem to find the distance $r = \sqrt{(d/2)^2 + (d/2)^2} = d/\sqrt{2}$. The electric potential at C is the sum of the potential due to the individual charges but since they produce the same potential, it is twice that of either one:

$$\begin{aligned} V &= \frac{2q}{4\pi\varepsilon_0}\frac{\sqrt{2}}{d} = \frac{2\sqrt{2}q}{4\pi\varepsilon_0 d} \\ &= \frac{(8.99\times10^9\,\mathrm{N\cdot m^2/C^2})(2)\sqrt{2}(2.0\times10^{-6}\,\mathrm{C})}{0.020\,\mathrm{m}} = 2.54\times10^6\ \mathrm{V}\ . \end{aligned}$$

(b) As you move the charge into position from far away the potential energy changes from zero to qV, where V is the electric potential at the final location of the charge. The change in the potential energy equals the work you must do to bring the charge in:

$$W = qV = \left(2.0\times10^{-6}\,\mathrm{C}\right)\left(2.54\times10^6\,\mathrm{V}\right) = 5.1\ \mathrm{J}\ .$$

(c) The work calculated in part (b) represents the potential energy of the interactions between the charge brought in from infinity and the other two charges. To find the total potential energy of the three-charge system you must add the potential energy of the interaction between the fixed charges. Their separation is d so this potential energy is $q^2/4\pi\varepsilon_0 d$. The total potential energy is

$$\begin{aligned} U &= W + \frac{q^2}{4\pi\varepsilon_0 d} \\ &= 5.1\,\mathrm{J} + \frac{(8.99\times10^9\,\mathrm{N\cdot m^2/C^2})(2.0\times10^{-6}\,\mathrm{C})^2}{0.020\,\mathrm{m}} = 6.9\ \mathrm{J}\ . \end{aligned}$$