29.23. Model: The charge is a point charge.
Visualize: Please refer to Figure Ex29.23.
Solve: **(a)** The electric potential of the point charge q is

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \left(9.0\times10^{9}\ \text{N m}^2/\text{C}^2\right)\left(\frac{2.0\times10^{-9}\ \text{C}}{r}\right) = \frac{18.0\ \text{N m}^2/\text{C}}{r}$$

For points A and B, $r = 0.01$ m. Thus,

$$V_\text{A} = V_\text{B} = \frac{18.0\ \text{N m}^2/\text{C}}{0.01\ \text{m}} = 1800\ \frac{\text{Nm}}{\text{C}} = 1800\left(\frac{\text{V}}{\text{m}}\right)\text{m} = 1800\ \text{V}$$

For point C, $r = 0.02$ m and $V_\text{C} = 900$ V.
(b) The potential energy of a charge q' at a point where the electric potential is V is $U = q'V$. The expression for the potential in part (a) assumes that we have chosen $V = 0$ V to be the potential at $r = \infty$. So, we are obtaining potential/potential energy relative to a zero of potential/potential energy at infinity. Thus,

$$U_\text{A} = U_\text{B} = (q')V = (-e)(V) = -\left(1.60\times10^{-19}\ \text{C}\right)(1800\ \text{V}) = -2.88\times10^{-16}\ \text{J}$$

$$U_\text{C} = \left(-1.60\times10^{-19}\ \text{C}\right)(900\ \text{V}) = -1.44\times10^{-16}\ \text{J}$$

(c) The potential differences are

$$\Delta V_\text{AB} = V_\text{B} - V_\text{A} = 1800\ \text{V} - 1800\ \text{V} = 0\ \text{V} \qquad \Delta V_\text{BC} = V_\text{C} - V_\text{B} = 900\ \text{V} - 1800\ \text{V} = -900\ \text{V}$$