P25.4 The potential difference is
\[ \Delta V = V_f - V_i = -5.00 \text{ V} - 9.00 \text{ V} = -14.0 \text{ V} \]
and the total charge to be moved is
\[ Q = -N_Ae = -(6.02 \times 10^{23})(1.60 \times 10^{-19} \text{ C}) = -9.63 \times 10^4 \text{ C} \]
Now, from \( \Delta V = \frac{W}{Q} \), we obtain
\[ W = Q \Delta V = (-9.63 \times 10^4 \text{ C})(-14.0 \text{ J/C}) = 1.35 \text{ MJ} \]

P25.9 Arbitrarily take \( V = 0 \) at point \( P \). Then the potential at the original position of the charge is (by Equation 25.3)
\[ \Delta V = V - 0 = V = -\vec{E} \cdot \vec{s} = -EL \cos \theta \quad \text{(relative to } P) \]
At the final point \( a \),
\[ V = -EL \quad \text{(relative to } P) \]
Because the table is frictionless and the particle-field system is isolated, we have
\[ (K + U)_i = (K + U)_f \]
or
\[ 0 - qEL \cos \theta = \frac{1}{2}mv^2 - qEL \]
solving for the speed gives
\[ v = \sqrt{\frac{2qEL(1-\cos \theta)}{m}} \]
\[ = \sqrt{\frac{2(2.00 \times 10^{-6} \text{ C})(300 \text{ N/C})(1.50 \text{ m})(1-\cos 60.0^\circ)}{0.0100 \text{ kg}}} \]
\[ = 0.300 \text{ m/s} \]
P25.12 (a) At a distance of 0.250 cm from an electron, the electric potential is
\[
V = k_e \frac{q}{r} = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2\right) \left(-1.60 \times 10^{-19} \text{ C}\right) \left(\frac{0.250 \times 10^{-2} \text{ m}}{0.250 \times 10^{-2} \text{ m}}\right)
\]
\[= -5.76 \times 10^{-7} \text{ V}\]

(b) The difference in potential between the two points is given by
\[
|\Delta V| = k_e \frac{q}{r_2} - k_e \frac{q}{r_1} = k_e q \left(\frac{1}{r_2} - \frac{1}{r_1}\right)
\]
Substituting numerical values,
\[
|\Delta V| = \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2\right) \left(-1.60 \times 10^{-19} \text{ C}\right)
\times \left(\frac{1}{0.250 \times 10^{-2} \text{ m}} - \frac{1}{0.750 \times 10^{-2} \text{ m}}\right)
\]
\[|\Delta V| = 3.84 \times 10^{-7} \text{ V}\]

(c) Because the charge of the proton has the same magnitude as that of the electron, only the sign of the answer to part (a) would change.

P25.27 The total change in potential energy is the sum of the change in potential energy of the \(q_1 - q_4, q_2 - q_4,\) and \(q_3 - q_4\) particle systems:
\[
U_e = q_4 V_1 + q_4 V_2 + q_4 V_3 = q_4 k_e \left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3}\right)
\]
\[
U_e = \left(10.0 \times 10^{-6} \text{ C}\right)^2 \left(8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2\right)
\times \left(\frac{1}{0.600 \text{ m}} + \frac{1}{0.150 \text{ m}} + \frac{1}{\sqrt{(0.600 \text{ m})^2 + (0.150 \text{ m})^2}}\right)
\]
\[U_e = 8.95 \text{ J}\]
P25.49  Substituting given values into \( V = \frac{k_e Q}{r} \), with \( Q = Nq \):

\[
7.50 \times 10^9 \, V = \frac{(8.99 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2) Q}{0.300 \, \text{m}}
\]

Substituting \( q = 2.50 \times 10^{-7} \, \text{C} \),

\[
N = \frac{2.50 \times 10^{-7} \, \text{C}}{1.60 \times 10^{-19} \, \text{C/e}^e} = 1.56 \times 10^{12} \, \text{electrons}
\]

P25.50  For points on the surface and outside, the sphere of charge behaves like a charged particle at its center, both for creating field and potential.

(a)  Inside a conductor when charges are not moving, the electric field is zero and the potential is uniform, the same as on the surface, and \( E = 0 \).

\[
V = \frac{k_e q}{R} = \frac{(8.99 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2)(26.0 \times 10^{-6} \, \text{C})}{0.140 \, \text{m}} = 1.67 \, \text{MV}
\]

(b)  \( E = \frac{k_e q}{r^2} = \frac{(8.99 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2)(26.0 \times 10^{-6} \, \text{C})}{(0.200 \, \text{m})^2} = 5.84 \, \text{MN/C} \) away

\[
V = \frac{k_e q}{R} = \frac{(8.99 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2)(26.0 \times 10^{-6} \, \text{C})}{0.200 \, \text{m}} = 1.17 \, \text{MV}
\]

(c)  \( E = \frac{k_e q}{R^2} = \frac{(8.99 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2)(26.0 \times 10^{-6} \, \text{C})}{(0.140 \, \text{m})^2} = 11.9 \, \text{MN/C} \) away

\[
V = \frac{k_e q}{R} = 1.67 \, \text{MV}
\]