2. Electric Potential and Work

The electric potential V from a single point charge q at a distance r is $V = k\frac{q}{r}$, where $k \approx 8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2}$.

(a) Electric Potential at Corner A

At corner A (0, 0), the distances are $r_{1A} = 0.050\,\mathrm{m}$ and $r_{2A} = 0.15\,\mathrm{m}$.

$$V_A = k\left(\frac{q_1}{r_{1A}} + \frac{q_2}{r_{2A}}\right) = (8.99 \times 10^9)\left(\frac{-5.0 \times 10^{-6}}{0.050} + \frac{+2.0 \times 10^{-6}}{0.15}\right)$$

$$V_A = (8.99 \times 10^9)(-1.0 \times 10^{-4} + 0.1333 \times 10^{-4}) \approx -7.79 \times 10^5\ \mathrm{V}$$

(b) Electric Potential at Corner B

At corner B, the distances are $r_{1B} = 0.15\,\mathrm{m}$ and $r_{2B} = 0.050\,\mathrm{m}$.

$$V_B = k\left(\frac{q_1}{r_{1B}} + \frac{q_2}{r_{2B}}\right) = (8.99 \times 10^9)\left(\frac{-5.0 \times 10^{-6}}{0.15} + \frac{+2.0 \times 10^{-6}}{0.050}\right)$$

$$V_B = (8.99 \times 10^9)(-0.3333 \times 10^{-4} + 0.4 \times 10^{-4}) \approx 5.99 \times 10^4\ \mathrm{V}$$

(c) Work Required to Move Charge q_3

The work W required is $W = q_3(V_A - V_B)$.

$$W = (3.0 \times 10^{-6})(-7.79 \times 10^5 - 5.99 \times 10^4) = (3.0 \times 10^{-6})(-8.389 \times 10^5) \approx -2.52\,\mathrm{J}$$

(d) Change in Potential Energy

The work done by an external force equals the change in potential energy, $W = \Delta U_E$. Since $W < 0$, the potential energy of the system **decreases**.

(e) & (f) Path Independence

The electrostatic force is a **conservative force**, so the work done is independent of the path taken. The work required is the **same**.