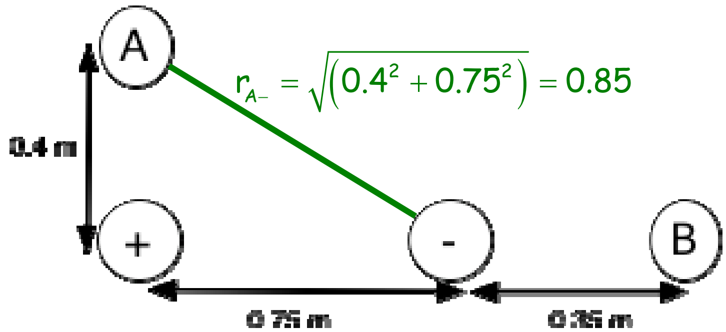
Two point charges (+10.0 μC and -10.0 μC) are located 8.00 cm apart.

a) Find the electric potential energy when a point charge of -4.2 μC is placed at point A.



$$U_E = \frac{kq_1q_2}{r_{12}}$$

$$U_A = k\left(\frac{q_Aq_+}{r_{A+}} + \frac{q_Aq_-}{r_{A-}} + \frac{q_+q_-}{r_{+-}}\right)$$

$$U_A = 8.99\times10^9\left(\frac{(-4.2\times10^{-6})(10\times10^{-6})}{0.4} + \frac{(-4.2\times10^{-6})(-10\times10^{-6})}{0.85} + \frac{(10\times10^{-6})(-10\times10^{-6})}{0.75}\right)$$

$$U_A = -1.70 \text{ J}$$

b) Find the electric potential energy when a point charge of -4.2 μC is placed at point B.

$$U_B = k\left(\frac{q_Bq_+}{r_{B+}} + \frac{q_Bq_-}{r_{B-}} + \frac{q_+q_-}{r_{+-}}\right)$$

$$U_B = 8.99\times10^9\left(\frac{(-4.2\times10^{-6})(10\times10^{-6})}{1.1} + \frac{(-4.2\times10^{-6})(-10\times10^{-6})}{0.35} + \frac{(10\times10^{-6})(-10\times10^{-6})}{0.75}\right)$$

$$U_B = -4.63\times10^{-1} \text{ J} = -0.463 \text{ J}$$

c) What is the change in electric potential energy when the -4.2 μC point charge is moved from A to B? Does it increase or decrease? Why?

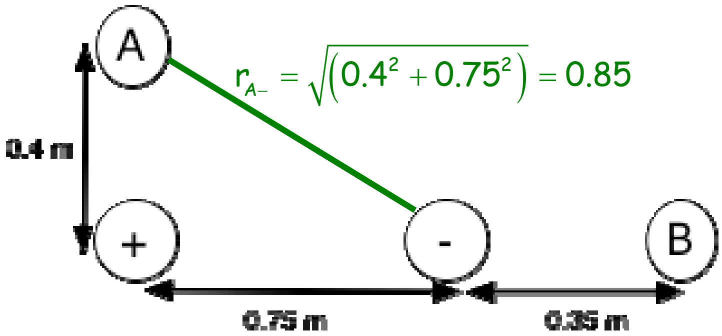
$$\Delta U_{A\to B} = U_B - U_A = -0.463 \text{ J} - (-1.70 \text{ J}) = 1.24 \text{ J}$$

The potential energy increases since the -4.2 μC charge moves closer to another negative charge and farther from the positive charge.

d) How much work is done by the electric force in moving the charge from A to B? Is it positive or negative? Explain.

$$\Delta U_{A\to B} = -W_{A\to B} = -1.24 \text{ J}$$

The work done by the electric force is negative because work must be done AGAINST the electric force to move the charge to a higher potential energy. This is like gravity doing negative work on you as you climb the stairs.



e) What is the electric potential at point A?

$$V = \frac{kQ}{r}$$

$$V_A = k\left(\frac{Q_+}{r_{A+}} + \frac{Q_-}{r_{A-}}\right) = 8.99 \times 10^9 \left(\frac{(10 \times 10^{-6})}{0.4} + \frac{(-10 \times 10^{-6})}{0.85}\right)$$

$$V_A = 1.19 \times 10^5 \text{ V} = 119 \text{ kV}$$

f) What is the electric potential at point B?

$$V_B = k\left(\frac{Q_+}{r_{B+}} + \frac{Q_-}{r_{B-}}\right) = 8.99 \times 10^9 \left(\frac{(10 \times 10^{-6})}{1.1} + \frac{(-10 \times 10^{-6})}{0.35}\right)$$

$$V_B = -1.75 \times 10^5 \text{ V} = -175 \text{ kV}$$

g) What is the change in electric potential if you were to move a test charge from A to B? Does it increase or decrease? Why?

$$\Delta V_{A\to B} = V_B - V_A = -175 \text{ kV} - 119 \text{ kV} = -294 \text{ kV}$$

The potential decreases since the + test charge moves closer to a negative charge and farther from the positive charge.