Lesson 6.3B: Electric Potential and Potential Difference

Unit 6: Electrostatics

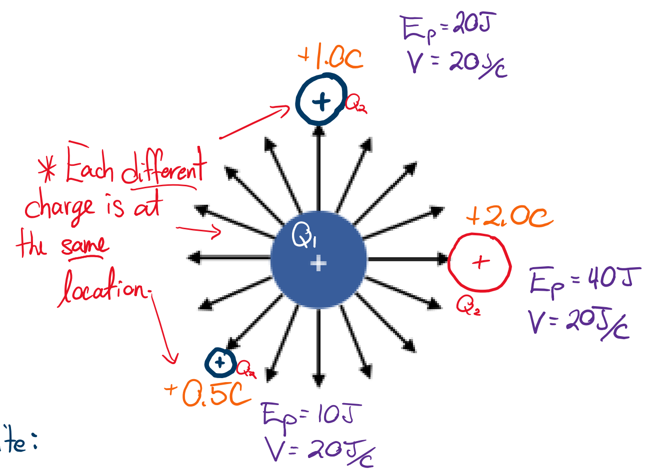
Electric Potential of Single Point Charges:

- Electric potential ***energy***: total work required to bring charges together
- Depends only on position in the electric field (not on the charge)
- Energy per unit charge

$$\boxed{V = \frac{E_p}{Q_T}}$$

V = Volts (V)
E_p = Potential Energy (J)
Q = Test Charge (C)

$1\ \text{Volt} = 1\ \text{J/C} = 1\ \text{Nm/C}$



Since V is independent of the "Test Charge," we write:

$$V = \frac{E_p}{Q_T} = \frac{\frac{KQ\cancel{Q_T}}{r}}{\cancel{Q_T}} \quad \therefore \boxed{V = \frac{KQ}{r}}$$

* Sub in sign of charge
* $V = 0$ when $r = \infty$

Example 1: Find the electric potential 6.0 cm away from a 2.0 µC charge.

$$V = \frac{kQ}{r}$$
$$= \frac{(9.0\times10^9)(2.0\times10^{-6})}{0.06}$$
$$V = 3.0\times10^5\ \text{V}$$

Example 2: Find the electric potential halfway between a +3.0 µC charge and a -4.0 µC charge which are 4.0 m apart.

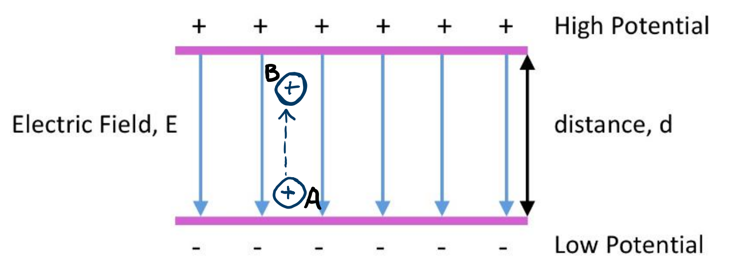
*Scalar so add potentials.

$$V = V_1 + V_2$$
$$= \frac{kQ_1}{r} + \frac{kQ_2}{r}$$
$$= \frac{k}{r}(Q_1 + Q_2)$$
$$= \frac{(9.0\times10^{9})}{2.0}\left[(3.0\times10^{-6}) + (-4.0\times10^{-6})\right]$$
$$\boxed{= -4500\,V \text{ or } -4.5\,kV}$$

Potential Difference:

Potential difference (voltage): is the difference in electric potential between 2 points.

$$\Delta V = V_B - V_A = \frac{\Delta E_p}{Q}$$



Example 3: How much work is required to move +1.00 µC between two points where the potential difference is 12.0 V?

$$W = \Delta E_p \therefore \Delta V = \frac{W}{Q} \Rightarrow W = \Delta V Q$$
$$= (12.0\,V)(1.00\times10^{-6}\,C)$$
$$\boxed{= 1.2\times10^{-5}\,J}$$

Electron Volts:

Simpler unit for solving problems on the atomic or nuclear scale (very small)

$$1\,eV = 1.6\times10^{-19}\,J$$

Ex. How many Joules in 750 eV?

$$(750\,\cancel{eV})(1.6\times10^{-19}\,J/\cancel{eV})$$
$$\boxed{= 1.2\times10^{-16}\,J}$$

Assignment: Sander-Gore Pg. 190 #1-3 | Pg. 192-193 # 2, 7-13