Electrostatics Summary

January 5, 2021 9:00 AM

like charges repel
opposite charges attract
a charge will attract a neutral

Coulomb's Law

$$\vec{F}_e = \frac{K Q_1 Q_2}{\vec{r}^{\,2}}$$

Vector equations: do not use charge's sign in equation. Use sign to figure out direction of force, etc only.

Q_1 ⊖ $\quad$ Q_2 ⊕

$F_{\text{on } Q_1} \rightarrow \qquad \leftarrow F_{\text{on } Q_2}$

Electric Field ($\vec{E}$) (due to a point charge)

$$\vec{E} = \frac{\vec{F}_e}{q_t}$$

$\vec{F}_e$ ← force felt by charge in field

q_t ← charge in field

$[\frac{N}{C}]$

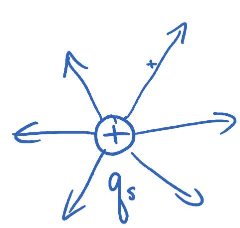
$$\vec{E} = \frac{K q_s}{r^2}$$

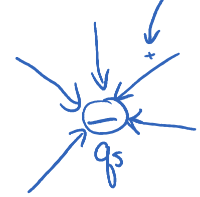
K: $9 \times 10^9 \frac{Nm^2}{C^2}$

q_s ← source charge, creating the field

r ← distance from source charge.

- $\vec{E}$ is a vector, so no charge signs in equation
- direction of $\vec{E}$ = the direction of force an imaginary positive test charge would feel





ex

q_+ ⊕

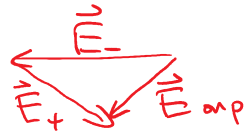
q_- ⊖ $\quad$ $\vec{E}_+$

$\vec{E}$ at point p?

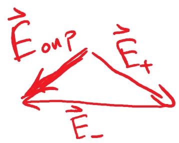
$$\vec{E}_- = \frac{K q_-}{r_-^2} \qquad \vec{E}_+ = \frac{K q_+}{r_+^2}$$

$\vec{E}_- = \frac{kq_-}{r_-^2}$ $\vec{E}_+ = \frac{kq_+}{r_+^2}$

add vectorally to find $\vec{E}$ at p



or



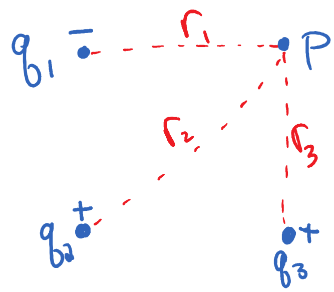
Electric Potential (V) (due to a point charge)

$V = \frac{kq_s}{r}$ $V = \frac{E_p}{q_t}$ ← electric potential energy $W = \Delta E = \Delta V q_t$ (change in energy E_p, E_k …)

$E_p = \frac{KQ_sQ_t}{r}$

V and E_p are scalar so we use the signs in the equations and then just add up. (no need to think about direction)

ex



What is the electric potential at p? (V)

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

$V_1 = -$ $V_2 = +$ $V_3 = +$

simply add: (not a vector) $\underset{-}{V_1} + \underset{+}{V_2} + \underset{+}{V_3} = V_{net\ on\ p}$

Between Parallel Plates

→ uniform $\vec{E}$ (same everywhere between plates)

← can be

→ uniform $\vec{E}$ (same everywhere)

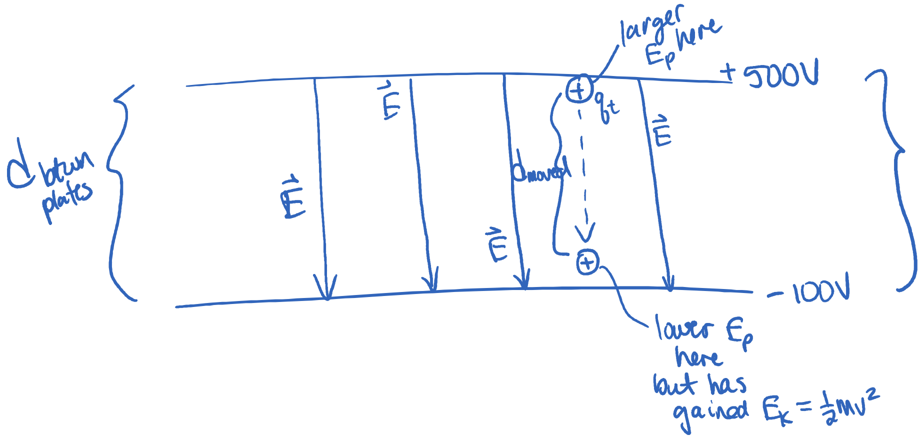
$$\Delta V = \frac{\Delta E_p}{q_t}$$ ← can be ΔE_k

$$\vec{E} = \frac{\Delta V}{d_{\text{btwn plates}}}$$

$$E_p = q_t \vec{E} d_{\text{moved along } \vec{E} \text{ lines}}$$

+ —— −1

− —— −10



$$\Delta V = 500 - {}^{-}100 = 600\text{V}$$