**Arbitrary!**

Not a proton

*Assume test point "p" = +1*

# P12 - 8.0 - Electrostatics Review

Electric Charge: a property of matter that causes it to experience a force when placed in an electric/electromagnetic field.

Coulomb: Unit of electrical charge, $C = 6.24E18\ e^{-}$ $(6\ quintillion\ electrons)$

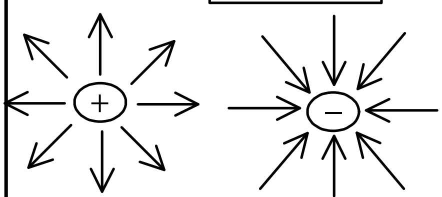
**Electric Field**: A property of each point in space when charge is present in any form.
: Uniform between two oppositely charged plates

$\vec{E} = \frac{\vec{F}}{Q}$ ; $Electric\ Field\ Strength\ \frac{N}{C}, \frac{V}{m}$

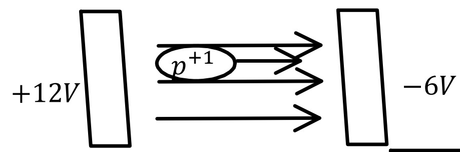
$\vec{F}$ ; $Electrostatic\ Force\ (N)$
$Q$ ; $Quantity\ of\ Charge\ (Coulombs; C)$

Coulombs Law :

Conventional* $+ \longrightarrow -$



*Opposite Unlike* Charges Attract. Like Charges Repel.*




Direction of Electric Field : Direction a Positve Charge would move. High Potential to Low.

*+ Work to overcome a Repulsive Force*

A Charge is surrounded by an Electric Field

As a charge moves along an electric field line, work is done by the electrical force.
The energy gained or lost by this charge moving in the field is a form of potential energy.

**Electric Potential:** work needed per unit of charge to move a unit charge between the two points in an **electric** field. Or work done in carrying a unit charge from infinity to any point.

Voltage: (Electric Potential Difference) the difference in electrical potential between two points.

At a Distance

Electromotiveforce emf

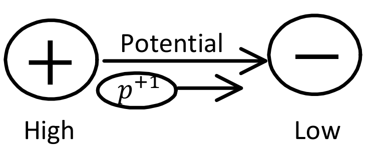
$\Delta V = \frac{\Delta E_p}{Q}$ ; $Potential\ Difference, Voltage\ \ V, \frac{J}{C}$

$\Delta V$ ; $Potential\ Difference\ (Voltage\ V)$
$E_p$ ; $Potential\ Energy$

At a Point

$V = \frac{kQ}{r}$ ; $\frac{J}{C} = V$ ; $Potential, Volts$

$k$ ; $Coulomb's\ Constant$: $k = 9.00 \times 10^9 \frac{Nm^2}{C^2}$
$r$ ; $Distance\ (m)$




$E_k$ of a test charge would increase when going from a higher potential to a lower potential

$1\ V\ is\ the\ number\ of\ electrons\ a\ Joule\ (Nm)\ can\ move\ between\ two\ points$

Electric Potential Energy : Energy needed to move a charge in an Electric Field

$E_p = \frac{kQQ}{r}$ ; $J$

+ charges move towards a low potential, away from high potential
− charges move towards a high potential, away from a low potential

A stationary charge will produce an electric field in the surrounding space.
If the charge is moving a magnetic field is also produced.
An electric field can also be produced by a changing magnetic field.

**Magnetism**

Electromagnetic Field: A property of space caused by an electric charge.

# P12 - 8.0 - Electrostatics Formulas Review

Theory $1C = 6.24E18\ e^-$ $1e^- = 1.6E-19C$

$\vec{E} = \frac{\vec{F}}{Q}$ ; *Electric Field Strength* $\frac{N}{C}, \frac{V}{m}$

$\Delta V = \frac{\Delta E_p}{Q}$ ; *Potential Difference, Volts* $V, \frac{J}{C}$

$\Delta V = V_f - V_i$

Total

$V_T = V_A + V_B$

$V_{AB^*} = V_A - V_B$ (Potential Between A & B)

$\vec{F} = \frac{kQ_1Q_2}{r^2}$ $\vec{E} = \frac{kQ}{r^2}$ $\vec{F} = \vec{E}Q$ $E_p = \frac{kQ_1Q_2}{r}$

Fixed Charge: $V = \frac{kQ}{r}$, $V = \vec{E}r$

>1 Charge: $\Delta E_p = \Delta VQ$

Plates: $\Delta E_p = \vec{F}d$, $\Delta V = \vec{E}d$

# Force

$\vec{F_g} = mg$ ; $N$

$g = \frac{F_g}{m}$ ; $\vec{E} \approx^* g$

$\vec{F_g} = \frac{GMm}{r^2}$ $\times r$

$\div m$

$g = \frac{GM}{r^2}$ ; $\vec{E} \approx^* g$ ; $Q \approx^* m$

# Energy

$W = Fd$ ; $J, Nm$

$E_p = -\frac{GMm}{r}$ ; $J$

$W = Fd$

$E_p = \left(\frac{GMm}{r^2}\right)d$

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

$\vec{E} = \frac{kQ}{r^2} = \vec{E}r = V = \frac{kQ}{r}$

$\frac{kQ}{r^2} \times Q \times r = \vec{E}Qr = \Delta VQ = E_p$

$\Delta E_p = \Delta VQ$

$\frac{kQQ}{r_f} - \frac{kQQ}{r_i} = \left(\frac{kQ}{r_f} - \frac{kQ}{r_i}\right)Q$

Useful Substitutions

Coulombs Law : Electrostatic Force - Between two charged particles

$\vec{F}$ ; *Electrostatic Force* $E_p$ ; *Potential Energy*

$W = \Delta E = \int \vec{F}d\vec{r}$

$\vec{F} = \frac{kQQ}{r^2}$ ; $N$ $\times r$ $E_p = \frac{kQQ}{r}$ ; $J$

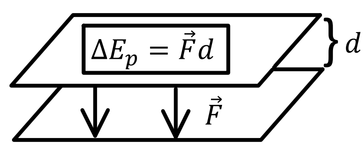
; *no* $+/-$ Logic ; $+/-$ *in formula*

$\div q$ $\div q$

$\vec{E} = \frac{kQ}{r^2}$ ; $\frac{N}{C}$ $\times r$ $V = \frac{kQ}{r}$ ; $\frac{J}{C} = V$

$\times q$ $\times q$

$\vec{F} = \vec{E}Q$ $\times r$ $\Delta E_p = \Delta VQ$




$W = Fd$

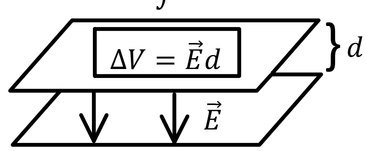
Parallel Plates

$V = \int \vec{E}d\vec{r}$

Point in Space

; *Potential*

$V_\infty = 0$




$\int = Area = \vec{@}d$

Calculus

VED is EFD!