Electric Force   Units: N

Coulombs Law

(Two Point Charges)

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|q_1 q_2|}{r^2} = k\frac{|q_1 q_2|}{r^2}$$

Force Due to Electric Field

$$\vec{F} = q_0\vec{E}$$

Force in a Uniform Field

$$F(z) = -\frac{dU}{dz}$$

Electric Fields   Units: $\frac{\text{N}}{\text{C}}$ or $\frac{\text{V}}{\text{M}}$

Electric Field From a Point Charge

$$E = \frac{kq}{r^2}$$

Electric Field From Force

$$\vec{E} = \frac{\vec{F}_0}{q_0}$$

Gauss's Law

$$E = \frac{Q_{\text{encl}}}{\epsilon_0 A}$$

From Equipotential Lines

$$E = -\nabla V$$

Electric Field of a Uniform Ring

$$\vec{E} = E_x\hat{i} = \frac{1}{4\pi\epsilon_0}\frac{Qx}{(x^2+r^2)^{\frac{3}{2}}}\hat{i}$$

Electric Field of a Line Segment

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{Q}{x\sqrt{x^2+a^2}}\hat{i}$$

Electric Field of a Charged Disk

$$E_x = \frac{\sigma x}{2\epsilon_0}\left[\frac{-1}{\sqrt{x^2+R^2}} + \frac{1}{x}\right]$$

Electric Potential Energy   Units: J

Note: Work of a field, $\Delta U = U_i - U_f$, <u>not</u> $U_f - U_i$

EPE Given a Voltage Difference

$$U = q_0 V$$

EPE in an Electric Field

$$U = q_0 E d$$

EPE for Two Point Charges

$$U = \frac{kq_1q_0}{r}$$

EPE From a Force

$$\int_{r_a}^{r_b} F_r dr$$

EPE Produced by a Collection of Point Charges on a Point Charge

$$U = \frac{q_0}{4\pi\epsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i}$$

Collective EPE of a Collection of Point Charges

(With Respect to a Specified Origin)

$$U = \frac{1}{4\pi\epsilon_0}\sum_{i<j}\frac{q_iq_j}{r_{ij}}$$

Electric Potential/Voltage   Units: $\frac{\text{J}}{\text{C}}$ or V

Note: Voltage, like electric potential energy is $\Delta V = V_i - V_f$, <u>not</u> $V_f - V_i$

Voltage Produced by a Point Charge

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

Voltage From EPE

$$V = \frac{U}{q_0}$$

Voltage of a Collection of Point Charges

$$V = k\sum\frac{q_i}{r_i}$$

Voltage of a Charge Distribution

$$V = k\int\frac{dQ}{r}$$

Change in Voltage (Outwards)

$$V_{r_2} - V_{r_1} = -\int_{r_1}^{r_2}\vec{E}\cdot dr$$

Torque   Units: N $\cdot$ m

Electric Dipole Moment

$$p = qd$$

(In the direction of d)

Torque (Scalar)

$$\tau = pE\sin\phi$$

Torque (Vector)

$$\vec{\tau} = \vec{p}\times\vec{E}$$

Potential Energy (Scalar)

$$U = -pE\cos\phi$$

Potential Energy (Vector)

$$U = -\vec{p}\cdot\vec{E}$$

Random

$$1 \text{ eV} = 1.602 \cdot 10^{-19} \text{ J}$$

Voltage of a Cylinder/Line

$$\Delta V_{ab} = \frac{\lambda}{2\pi\epsilon_0} \ln \frac{r_b}{r_a}$$

Voltage Above a Ring of Charge

$$V = \frac{KQ}{\sqrt{x^2 + a^2}}$$

x: distance above ring
a: radius of ring

Potential of a Line of Charge

$$V = \frac{KQ}{2a} \ln \left(\frac{\sqrt{a^2 + x^2} + a}{\sqrt{a^2 + x^2} - a} \right)$$

Field of an Infinite Plane

$$E = \frac{\sigma}{2\epsilon_0}$$

Field of an Infinite Wire

$$E = \frac{\lambda}{2\pi r \epsilon_0}$$

Field of an Infinite Cylinder (Interior)

$$E = \frac{\rho r}{2\epsilon_0}$$

Field of an Infinite Slab (Interior)

$$E = \frac{\rho s}{2\epsilon_0}$$

Field Inside a Sphere

$$E = \frac{\rho r}{3\epsilon_0}$$