Chapter 22

Colomb's Law

(Force between two point charges)

$$F_e = k_e \frac{|q_1||q_2|}{r^2}$$

Force of multiple Charges on a single point

$$\sum \vec{F}_1 = \vec{F}_{21} + \vec{F}_{31} + \vec{F}_{41}$$

Definition of electric field

$$\vec{E} = \frac{\vec{F_e}}{q_0}$$

Using test charge to determine force direction of the electric field

$$\vec{F_e} = k_e \frac{q q_0}{r^2} \hat{r}$$

Electric field due to a finite num of point charges

$$\vec{E} = k_e \sum_i \frac{q_i}{r_i^2} \hat{r}_i$$

Acceleration of a charge particle

$$\vec{a} = \frac{q\vec{E}}{m}$$

$k_e = 8.987 \times 10^9\ Nm^2/C^2$ – Coulomb Constant

$e = \pm 1.602 \times 10^{-19}\ C$ – Charge of electron/proton

q_n = Electric force exerted by charge n

r = Distance between point charges

$\vec{F}$ = Vector representing force on a charge

$\vec{E}$ = Vector representing the force of an electric field

$\vec{F_e}$ = Vector representing the electric force of an electric field acting on a test charge within the bounds of the electric field

$\hat{r}$ = Unit vector pointed from q toward q_0

r_i = Distance from the i^{th} source charge q_i to point P

m = mass of particle

Velocity as function of position

$$V_f^2 = V_i^2 + 2a(x_f - x_i)$$

V = Velocity

a = acceleration

x = position

Chapter 23

Electric Flux

$$\phi_E = EA$$

ϕ_E = Electric flux, aka the magnitude of the electric field over the surface area

A = Area of surface

Electric flux at an angle

$$\phi_E = EA\cos\theta$$

θ = Angle of surface A to $A_\perp$

Surface integral of electric flux

$$\phi_E = \int_{surface} \vec{E} \cdot d\vec{A}$$

$\oint$ = Integral over a closed surface

Net flux over a closed surface

$$\phi_E = \oint E_n \, dA$$

E_n = Component of electric field normal to the surface

Net flux through gaussian surface

$$\phi_E = \frac{q}{\varepsilon_0}$$

$\varepsilon_0 = 8.854 \times 10^{-12}\ C^2/Nm^2$ - Permittivity of free space

Gauss' Law -
net flux through
any closed surface

$$\phi_e = \frac{q_{in}}{\varepsilon_0}$$

q_{in} = represents the net charge inside the surface

Chapter 24

Change in electric potential energy of a system

$$\Delta U_E = -q \int_{A}^{B} \vec{E} \cdot d\vec{s}$$

U_E = Electric potential energy of a charge field

d = Distance from A to B

Electric Potential

$$V = \frac{U_E}{q}$$

$$\Delta V = \frac{\Delta U_E}{q} = -\int_{A}^{B} \vec{E} \cdot d\vec{s}$$

V = Electric potential

Work done by an external agent

$$W = q\Delta V$$

W = work

$1\ eV = 1.602 \times 10^{-19}\ J$ - Electron Volt (times # volts)

Change in potential energy

$$\Delta U_E = q\Delta V = -q\vec{E} \cdot \vec{s}$$

Total Energy

K_E = Kinetic Energy

$$\Delta K_E + \Delta U_E = 0$$

Potential Difference

$$V_B - V_A = k_e q\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

$$V = k_e \frac{q}{r}$$

$$V = k_e \sum_i \frac{q_i}{r_i}$$

Electric potential energy of a pair of point charges

$$U_E = k_e \frac{q_1 q_2}{r_{12}}$$

Electric field of radial distance

$$E_r = -\frac{dV}{dr}$$

Electric potential at point P

$$dV = k_e \frac{dq}{r} = k_e \int \frac{dq}{r}$$

Distance from field and potential

$$E = \frac{-V}{d} \qquad V = \frac{kQ}{d}$$

Chapter 25

C = Capacitance (F)

Q = Charge

ΔV = Potential difference

a = Radius of sphere

σ = Surface charge density

Capacitance

$$C = \frac{Q}{\Delta V}$$

capacitance of an isolated charged sphere

$$C = \frac{Q}{\Delta V} = \frac{Q}{k_e Q/a} = \frac{a}{k_e} = 4\pi\varepsilon_0 a$$

surface charge density on each plate

$$\sigma = \frac{Q}{A}$$