

Chapter 22

Coulomb'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

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

Definition of electric field

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

Using test charge to determine force direction of the electric field

$$\vec{F}_e = k_e \frac{qq_0}{r^2} \hat{r}$$

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

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

$k_e = 8.987 \times 10^9 \text{ Nm}^2/\text{C}^2$ - Coulomb Constant

$e = \pm 1.602 \times 10^{-19} \text{ C}$ - 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

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

Chapter 23

Electric Flux

$$\Phi_E = EA$$

Electric flux at an angle

$$\Phi_E = EA \cos \theta$$

Surface integral of electric flux

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

Net flux over a closed surface

$$\Phi_E = \oint E_n dA$$

Net flux through gaussian surface

$$\Phi_E = \frac{q}{\epsilon_0}$$

V = Velocity

a = acceleration

x = position

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

A = Area of surface

θ = Angle of surface A to A_\perp

\oint = Integral over a closed surface

E_n = Component of electric field normal to the surface

$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{Nm}^2$ - Permittivity of free space

Gauss' Law -
net flux through
any closed surface

$$\phi_e = \frac{q_{in}}{\epsilon_0}$$

Chapter 24

Change in electric
potential energy of
a system

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

Electric Potential

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

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

Work done by an
external agent

$$W = q\Delta V$$

Change in
potential energy

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

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

U_E = Electric potential energy
of a charge field

d = Distance from A to B

V = Electric potential

W = Work

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

Total Energy

$k_E = \text{kinetic Energy}$

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

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

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

$$V = \frac{kQ}{d}$$

$$\Delta U = -qEd$$

Chapter 25

Capacitance

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

Capacitance of an isolated charged sphere

$$C = \frac{Q}{\Delta V} = \frac{Q}{k_e Q/a} = \frac{a}{k_e} = 4\pi\epsilon_0 a$$

Surface charge density on each plate

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

C = Capacitance (F)

Q = Charge

ΔV = Potential difference

a = Radius of sphere

σ = Surface charge density