Physics 12 Formula Sheet for Final Exam

Constants

$k = 8.99 \cdot 10^{9} \cdot \frac{N \cdot m^2}{C^2}$ $\quad k = \frac{1}{4 \cdot \pi \cdot \varepsilon_0}$

$e = 1.602 \cdot 10^{-19} \cdot C$

$mass\_e = 9.11 \cdot 10^{-31} \cdot kg$

$\varepsilon_0 = 8.85 \cdot 10^{-12} \cdot \frac{C^2}{N \cdot m^2}$

$\lambda = \frac{Q}{L}$

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

$\rho = \frac{Q}{Vol}$

Electric Force

$F = k \cdot \frac{Q_1 \cdot Q_2}{r^2}$

Electric Field

$E = \frac{F}{q} = k \cdot \frac{Q}{r^2} = k \cdot \int \frac{1}{r^2}\, dQ$

Electric Flux (Gauss)

$\Phi_E = E \cdot A = \int E\, dA = \frac{Q_{encl}}{\varepsilon_0}$

Line of Charge

$E = \frac{1}{2 \cdot \pi \cdot \varepsilon_0} \cdot \frac{\lambda}{r}$

Line of Charge: Finite

$E = \frac{\lambda}{2 \cdot \pi\, \varepsilon_0} \cdot \frac{L}{r \cdot \sqrt{L^2 + 4r^2}}$

Spherical Surface

Outside

$E = \frac{1}{4 \cdot \pi \cdot \varepsilon_0} \cdot \frac{Q}{r^2}$

Inside

$E = 0$

Solid Sphere

$E = \frac{1}{4 \cdot \pi \cdot \varepsilon_0} \cdot \frac{Q}{r_0^{3}} \cdot r$

where r0 is radius of sphere and r is distance from center

Infinite Plane

$E = \frac{\sigma}{2 \cdot \varepsilon_0} = \frac{\rho \cdot d}{2 \cdot \varepsilon_0}$

Two Parallel Plates

$E_{left} = E_{right} = 0$

$E_{inside} = \frac{\sigma}{\varepsilon_0}$

DC Circuits

Series

$V_{eff} = V_1 + V_2 + \ldots$

$Q_{eff} = Q_1 = Q_2 = \ldots$

$I_{eff} = I_1 = I_2 = \ldots$

$\frac{1}{C_{eff}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$

$R_{eff} = R_1 + R_2 + \ldots$

Parallel

$V_{eff} = V_1 = V_2 = \ldots$

$Q_{eff} = Q_1 + Q_2 + \ldots$

$I_{eff} = I_1 + I_2 + \ldots$

$C_{eff} = C_1 + C_2 + \ldots$

$\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

Current

$I = \frac{d}{dt} Q$

Power

$P = I \cdot V = I^2 \cdot R = \frac{V^2}{R}$

Resistance

$V = I \cdot R$

Resistivity (ρ)

$R = \rho \cdot \frac{L}{A}$

Junction Rule

$I_{in} = I_{out}$

Loop Rule

$0 = \sum_{loop} \xi + \sum_{loop} (I \cdot R)$

RC Circuits

Time Constant

$\tau = R \cdot C$

EMF

$\xi = \sum_{loop} (I \cdot R) + \sum_{loop} \frac{Q}{C}$

Voltage (time)

$V_{cap} = \xi \cdot \left(1 - e^{\frac{-t}{R \cdot C}}\right)$

Voltage

$V = I \cdot R = \frac{Q}{C}$

Current

$I = \frac{\xi}{R} \cdot e^{\frac{-t}{R \cdot C}}$

Magnetism

Force: Wire

$$F = I\cdot(\vec{L}\times\vec{B}) = I\cdot L\cdot B\cdot \sin(\theta)$$

Force: Particle

$$F = q\cdot(\vec{v}\times\vec{B}) = q\cdot v\cdot B\cdot \sin(\theta)$$

Electron Mas Ratio

$$\frac{e}{m} = \frac{v}{B\cdot r} = \frac{E}{B^2\cdot r}$$

Cyclotron: Radius

$$r = \frac{m\cdot v}{q\cdot B}$$

Cyclotron: Period

$$T = \frac{1}{f} = \frac{2\cdot\pi\cdot m}{q\cdot B}$$

Electric and Magnetic Field

$$\vec{F} = q\cdot(\vec{E} + \vec{v}\times\vec{B})$$

Torque: Magnetic Dipole Moment

$$\vec{\tau} = N\cdot I\cdot(\vec{A}\times\vec{B}) \qquad \vec{\mu} = N\cdot I\cdot\vec{A}$$

$$\vec{\tau} = \vec{\mu}\times\vec{B}$$

Magnetic Sources

Ampere's Law

$$\int \vec{B}\, d\vec{L} = \mu_0\cdot I_{encl}$$

Biot-Savart Law

$$\vec{B} = \frac{\mu_0\cdot I}{4\cdot\pi}\cdot\int \frac{1}{r^2}\, d\vec{L}\times\hat{r}$$

Solenoid

$$n = \frac{N}{L} \qquad B = \mu_0\cdot n\cdot I$$

Toroid (Circle Solenoid)

$$B_{in} = \frac{\mu_0\cdot N\cdot I}{2\cdot\pi\cdot r}$$

$$B_{out} = 0$$

Permeability of Free Space

$$\mu_0 = 4\cdot\pi\cdot 10^{-7}\, T\cdot\frac{m}{A}$$

Infintie Wire

$$B = \frac{\mu_0}{2\cdot\pi}\cdot\frac{I}{r}$$

B-Field Inside Wire

$$B = \frac{\mu_0\cdot I\cdot r}{2\cdot\pi\cdot R^2}$$

Parallel Wires

$$B_1 = \frac{\mu_0}{2\cdot\pi}\cdot\frac{I_1}{d} \qquad F_2 = \frac{\mu_0}{2\cdot\pi}\cdot\frac{I_1\cdot I_2}{d}\cdot L_2$$

Electromagnetic Induction

Faraday's Law

$$\Phi_B = \int \vec{B}\, d\vec{A}$$

$$\xi = \int \vec{E}\, d\vec{L} = -N\cdot\left(\frac{d}{dt}\Phi_B\right)$$

Moving Conductor

$$\xi = B\cdot L\cdot v$$

$$F = I\cdot L\cdot B = \frac{B^2\cdot L^2}{R}\cdot v$$

$$P = I^2\cdot R = \frac{B^2\cdot L^2\cdot v^2}{R}$$

AC Generator

$$\xi = N\cdot B\cdot A\cdot\omega\cdot\sin(\omega\cdot t)$$

Transformers

$$\frac{V_{out}}{V_{in}} = \frac{N_{out}}{N_{in}} \qquad I_{in}\cdot V_{in} = I_{out}\cdot V_{out}$$

Inductance

Self-Inductance

$$L = N\cdot\frac{\Phi_B}{I}$$

$$\xi = -L\cdot\left(\frac{d}{dt}I\right)$$

Mutual Inductance

$$\Phi_B = L\cdot I + M\cdot I$$

LC Circuit

$$0 = \frac{Q}{C} - L\cdot\left(\frac{d}{dt}I\right)$$

$$\omega^2 = \frac{1}{L\cdot C}$$

LR Circuit

$$0 = V_0 - L\cdot\left(\frac{d}{dt}I\right) - I\cdot R$$

$$V_R = V_0\cdot\left(1 - e^{-R\cdot L^{-1}\cdot t}\right)$$

Energy: Inductor

$$U = \frac{1}{2}\cdot L\cdot I^2$$

Energy: Capacitor

$$U = \frac{1}{2}\cdot C\cdot V^2$$

Energy Density

$$u = \frac{1}{2}\cdot\frac{B^2}{\mu_0}$$

Maxwell's Equations

Ampere

$$\int \vec{B}\, d\vec{A} = \mu_0\cdot I + \mu_0\cdot\varepsilon_0\cdot\left(\frac{d}{dt}\Phi_B\right)$$

Faraday

$$\int \vec{E}\, d\vec{L} = -\frac{d}{dt}\Phi_B$$

Gauss

$$\int \vec{E}\, d\vec{A} = \frac{Q_{encl}}{\varepsilon_0}$$

$$\int \vec{B}\, d\vec{A} = 0$$

Light

$$c = \lambda\cdot f = \frac{1}{\sqrt{\mu_0\cdot\varepsilon_0}}$$