12 Physics – Electricity & Magnetism Important Formula

Coulomb's law

$$F = k\frac{|q_1||q_2|}{r^2}$$

Electric Field

$$E = k\frac{|q|}{r^2} = \frac{|F|}{|q|}$$

Relationship of k to ϵ

$$k = \frac{1}{4\pi \epsilon_0}$$

Electric Field due to an infinite Line of charge

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

Electric Field due to ring of charge

$$E = \frac{kqa}{(a^2 + R^2)^{\frac{3}{2}}}$$

Here a = distance of point from centre of the ring

Electric Field due to an infinite sheet

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

Electrical Field inside a spherical shell

$$E = \frac{kqr}{R^3}$$

Electric Field outside a spherical shell

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

Electric Dipole

$$E = \frac{2kp}{r^3}$$

Potential Difference

$$\Delta V = V_B - V_A = \frac{W}{q} = -\vec{E}.\vec{d}$$

Electric Potential due to a Point

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

12 Physics – Electricity & Magnetism Important Formula

Charge

Potential Energy of a Pair of Charges

$$PE = q_2 V_1 = k\frac{q_1 q_2}{r}$$

Work and Potential

$$\Delta U = U_f - U_i = -W$$

$$U = -W_\infty$$

$$W = \vec{F}.\vec{d} = Fd\,cos\theta$$

$$W = q\int E.ds$$

$$\Delta V = V_f - V_i = -\frac{W}{q}$$

$$V = -\int \vec{E}.\overrightarrow{ds}$$

Flux: the rate of flow

$$\Phi = \oint \vec{E}.\overrightarrow{dA}$$

$$\int E(cos\theta)dA$$

Gauss' Law

$$\Phi = \frac{q_{enc}}{\epsilon_0}$$

$$\oint E.dA = \frac{q_{enc}}{\epsilon_0}$$

Parallel-Plate Capacitor

$$C = \epsilon_0 \frac{A}{d}$$

When air/ vacuum is in between plates.

Parallel-Plate Capacitor with Conducting slab

$$C = \epsilon_0 \frac{A}{d-t}$$

Here t is the thickness of the conducting slab and t < d

Electrical Energy Stored in a Capacitor

$$U_E = \frac{QV}{2} = \frac{CV^2}{2} = \frac{Q^2}{2C}$$

12 Physics – Electricity & Magnetism Important Formula

Magnetic Force acting on a charge q	$\vec{F} = qvB\sin\theta$
	$\vec{F} = q(\vec{v}\times\vec{B})$
Force on a Wire in a Magnetic Field	$\vec{F} = BIl\sin\theta$
	$\vec{F} = Il\times B$
Torque on a Rectangular Loop	$\tau = NBIA$
Charged Particle in a Magnetic Field	$r = \frac{mv}{qB}$
Magnetic Field Around a Wire	$B = \frac{\mu_0 I}{2\pi r}$
Magnetic Field at the center of an Arc	$B = \frac{\mu_0 i\phi}{4\pi r}$ Here Ø is the angle suspended
Force Between Two Conductors	$\frac{F_1}{l} = \frac{\mu_0 I_1 I_2}{2\pi d}$
Magnetic Field inside of a Solenoid	$B = \mu_0 nI$
Magnetic Dipole Moment	$\mu = NiA$
Magnetic Flux through a closed loop	$\Phi = BA\cos\theta$
Charge per unit area	$\sigma = \frac{q}{A}$
Energy Density	$u = \frac{1}{2}\epsilon_0 E^2$
Time Constant	$\tau = RC$
Drift Velocity	$v_d = \frac{eE\tau}{m}$

12 Physics – Electricity & Magnetism Important Formula

Emf	$\varepsilon = IR + Ir$ R = external resistance, r = internal resistance
Resistivity	$\rho = \frac{E}{J}$ $\rho = \frac{RA}{L}$
Variation of Resistance with Temperature	$\rho - \rho_0 = \rho_0 \alpha (T - T_0)$
Current Density	$i = \int \text{j}.ds$ $J = (ne)V_d$
Voltage, series circuits	$V_c = \frac{q}{C}$ $V_R = IR$ $\frac{V_X}{X} = \frac{V_R}{R} = I$ $V^2 = V_R^2 + V_X^2$
Phase Angle of a series RL or RC circuit	$tan\phi = \frac{X}{R} = \frac{V_X}{V_R}$ $cos\phi = \frac{V_R}{V} = \frac{R}{Z}$
Impedance of a series RL or RC circuit	$Z^2 = R^2 + X^2$ $E = IZ$ $\frac{Z}{V} = \frac{X_C}{V_C} = \frac{R}{V_R}$
Series RCL Impedance	$Z^2 = R^2 + (X_L - X_C)^2$

12 Physics – Electricity & Magnetism Important Formula

Damped Oscillations in an RCL Series Circuit

$$q = Qe^{Rt|2L}\cos(\omega' t + \phi)$$

$$\omega^{\wedge\prime} = \sqrt{w^2 - \left(\frac{R}{2L}\right)^2}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

Parallel RCL Circuits

$$I_r = \sqrt{I_R^2 + (I_C - I_L)^2}$$

$$tan\phi = \frac{I_C - I_L}{I_R}$$

Equivalent Series Circuit

$$R = Z_T\ cos\theta$$

$$X = Z_T\ cos\theta$$

Instantaneous Voltage of a Sine Wave

$$V = V_{max}\ Sin2\pi ft$$

Maximum and rms Values

$$I = \frac{1_m}{\sqrt{2}}$$

$$V = \frac{V_m}{\sqrt{2}}$$

RLC Circuits

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$P_{avg} = IV\ cos\phi$$

$$PF = cos\phi$$

12 Physics – Electricity & Magnetism Important Formula

A Cylindrical Changing Magnetic	$\oint E.ds = E2\pi r = \frac{d\Phi_B}{dt}$ $\Phi_B = BA = B\pi r^2$ $\frac{d\Phi}{dt} = A\frac{dB}{dt}$ $\varepsilon = -N\frac{d\Phi}{dt}$
Faraday's Law of Induction	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$
Motional emf	$\varepsilon = Blv$
emf Induced in a Rotating Coil	$\varepsilon = NAB\omega\ sin\omega t$
Self-Induced emf in a Coil due to changing current	$\varepsilon = -L\frac{\Delta I}{\Delta t}$
Inductance per unit length	$\frac{L}{l} = \mu_0 n^2 A$
Amperes' Law	$\oint B.ds = \mu_0 i_{enc}$
Inductance of a Coil	$L = \frac{N\Phi}{I}$
Magnetic Energy Stored in a Inductor	$U_B = \frac{1}{2}LI^2$
Electrical Energy Stored in a Capacitor	$U_E = \frac{QV}{2} = \frac{CV^2}{2} = \frac{Q^2}{2C}$
Resonant Frequency	$f_R = \frac{1}{2\pi\sqrt{LC}}$ $\omega = \frac{1}{\sqrt{LC}}$