$F = k\frac{QQ}{r^2}\vec{a}_r = Q\vec{E}$

$k = \frac{1}{4\pi\varepsilon_0}$

$\vec{F} = Q(\vec{E} + \vec{u}\times\vec{B})$

$d\vec{H} = \frac{I d\vec{l}\times\vec{R}}{4\pi R^3}$

$V_{emf} = -\frac{\partial\lambda}{\partial t} = -N\frac{d\Phi}{dt}$

$L = \frac{\lambda}{I} = \frac{N\Phi}{I}$

Gauss's Law

$\oint_s \vec{D}\cdot d\vec{s} = \int_v \rho_v\, dv = Q_{enc} = \Psi$

$\vec{D} = \varepsilon_0\vec{E}$ (free space)

$\vec{D} = \varepsilon_0\varepsilon_r\vec{E}$ (di-region)

$\vec{D} = \varepsilon_0\vec{E} + \vec{P}$ (anywhere)

$V = -\int_\infty^r \vec{E}\cdot d\vec{l}$

$\vec{E} = -\nabla V$

$\rho_v = \nabla\cdot\vec{D}$

$\vec{J} = \sigma\vec{E}$

Ampére's Law

$\oint_L \vec{H}\, d\vec{l} = \int_s \vec{J}\cdot d\vec{s} = I_{enc}$

$H_\phi \vec{a}_\phi$

$\vec{B} = \mu_0\vec{H}$ (free)

$\vec{B} = \mu_0\mu_r\vec{H}$ (di-reg)

$\Phi = \oint_s \vec{B}\cdot d\vec{s} = \oint_L \vec{A}\cdot d\vec{l}$

$\vec{J} = \nabla\times\vec{H}$

$\vec{B} = \nabla\times\vec{A}$

polarization volume charge destiny

$\rho_{pv} = -\nabla\cdot\vec{P}$

polarization surface charge destiny

$\rho_{ps} = \vec{P}\cdot\vec{a}_n|_{\rho=a}$

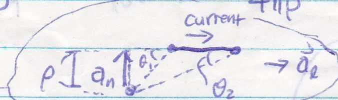
Surface charge destiny

$\rho_{sa} = \vec{D}\cdot\vec{a}_n|_{\rho=a}$

$\vec{J} = \frac{\partial\vec{D}}{\partial t} = \varepsilon\frac{\partial\vec{E}}{\partial t}$

$\nabla\times\vec{E} = -\mu\frac{\partial\vec{H}}{\partial t}$

$\vec{H} = \frac{I}{4\pi\rho}(\cos\theta_1 - \cos\theta_2)\hat{a}_\phi$



for ∞ line $\theta_1 = 180°$ $\theta_2 = 0°$

$\vec{a}_\phi = \vec{a}_\ell\times\vec{a}_n$

partial time derivative of volume charge destiny

$-\frac{\partial\rho_v}{\partial t} = \nabla\cdot\vec{J}$

Possion Eq ($\rho_v \neq 0$)

$\nabla^2 V = -\frac{\rho_v}{\varepsilon}$

Laplace Eq ($\rho_v = 0$)

$\nabla^2 V = 0$

ENERGY

W_E (destiny) $= \frac{1}{2}\vec{D}\cdot\vec{E}$

W_M (destiny) $= \frac{1}{2}\vec{B}\cdot\vec{H}$

W_e (total) $= \frac{1}{2}\int_v \vec{D}\cdot\vec{E}\, dv$

W_m (total) $= \frac{1}{2}\int_v \vec{B}\cdot\vec{H}\, dv$

Power lost destiny

$\vec{J}\cdot\vec{E}$

$C = \cancel{QV}\; Q/V$

$RC = \frac{\varepsilon}{\sigma}$ $\quad G = \frac{1}{R}$

given $\vec{H}_1, \mu_1 \Rightarrow \vec{H}_2, \vec{B}_2, \vec{M}_1$

$M_1 = \chi_m H_1$

$\mu_r = 1 + \chi_m = \frac{\mu}{\mu_0}$

$\vec{H}_{1n} = (\vec{H}_1\cdot\vec{a}_n)\vec{a}_n$

$\vec{a}_n = \frac{\nabla f}{|\nabla f|}$ ← vector, ← scalar

$\rightarrow \mu_2 \vec{H}_{2n} = \mu_1\vec{H}_{1n}$

$\vec{H}_1 = \vec{H}_{1t} + \vec{H}_{1n}$

$\vec{H}_{2t} = \vec{H}_{1t}$

$\vec{H}_2 = \vec{H}_{2t} + \vec{H}_{2n}$

$\vec{B} = \mu\vec{H}_2$

point

$Q = \oint_s \vec{D} \cdot d\vec{s}$

line

$\rho_L l = \oint_s \vec{D} \cdot d\vec{s}$

Volume

$\int_v \rho_v dv = \oint_s \vec{D} \cdot d\vec{s}$

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→ Colomb's Law:
the force $\vec{F}$ between Q_1 and Q_2 is
1) along the line joining them.
2) $\vec{F} \propto Q_1 Q_2$
3) $\vec{F} \propto \frac{1}{R^2}$

Unit for $\vec{F}$: N

→ The "electric field intensity" or "electric field strength"
$\vec{E}$ is the force per unit charge when placed in an electric field

unit for $\vec{E}$: V/m

→ Ampère's law states that the line integral of $\vec{H}$ around a closed path is the same as the net current I_{enc} by the path

Unit for $\vec{D}$: C/m^2

unit for ψ: C

line

$\vec{E} = \int_L \frac{\rho_L dl}{4\pi\varepsilon_0 R^2} \vec{a}_R$

unit for $\vec{H}$: A/m

$x^2+y^2=9$ $z=0$ $10A \to a_\phi$
find $H(0,0,4)$

unit for energy W: J

surface

$\vec{E} = \int \frac{\rho_s ds}{4\pi\varepsilon_0 R^2} \vec{a}_R$

unit for Φ: Wb

$d\vec{H} = \frac{I(d\vec{l} \times \vec{R})}{4\pi R^3}$

$d\vec{l} = \rho d\phi \hat{a}_\phi$

unit for current I: A

volume

$\vec{E} = \int_v \frac{\rho_v dv}{4\pi\varepsilon_0 R^2} \vec{a}_R$

unit for $\vec{B}$: Wb/m^2

$\vec{R} = r - r'$

$r = h\vec{a}_z$

$r' = \rho \vec{a}_\rho$

$r - r' = h\vec{a}_z - \rho\vec{a}_\rho$

$R = r - r'$

$|R| = \sqrt{\rho^2 + h^2}$

unit for ρ_v: C/m^3

unit for $\vec{J}$: A/m^2

unit for $\vec{A}$: Wb/m

$H = \int dH_z a_z = \int_0^{2\pi} \sim d\phi$

$\vec{H} = \frac{I\rho^2 a_z}{2(\rho^2+h^2)^{3/2}}$