Physics Quiz 3 Formulas

$\mu_0 = 4\pi \cdot 10^{-7}\text{N/A}^2$, $\epsilon_0 = 8.854 \cdot 10^{-12}\text{C}^2/\text{Nm}^2$

$$\vec{F}^{\text{B}} = q(\vec{v} \times \vec{B}) = I\vec{\ell} \times \vec{B} \tag{1}$$

Maxwell's Equations

Gauss' Law for Electricity: $\Phi_E = \oint_A \vec{E} \cdot d\vec{A} = \oint_V (\nabla \cdot \vec{E}) \cdot d\vec{V} = \frac{q_{\text{enc}}}{\epsilon_0}$ (2)

Gauss' Law for Magnetism: $\Phi_B = \oint_A \vec{B} \cdot d\vec{A} = \oint_V (\nabla \cdot \vec{B}) \cdot d\vec{V} = 0$ (3)

Faraday's Law: $\oint_L \vec{E} \cdot d\vec{l} = \oint_A (\nabla \times \vec{E}) \cdot d\vec{A} = -\frac{d\Phi_B}{dt}$ (4)

Ampere's Law: $\oint_L \vec{B} \cdot d\vec{l} = \oint_A (\nabla \times \vec{B}) \cdot d\vec{A} = \mu_0 I_{\text{int}} + \mu_0\epsilon_0\kappa\frac{d\Phi_E}{dt}$ (5)

Chapter 29

Inductance: $\mathcal{E}_{\text{ind}} = -L\frac{dI}{dt}$ **Solenoid:** $L = \frac{\mu_0 N^2 A}{l}$ **Toroid:** $L = \frac{\mu_0 N^2}{2\pi} \ln\left(\frac{R_{\text{out}}}{R_{\text{in}}}\right) h$ (6)

where A is the inner area, l is the length, R_{out} and R_{in} are the outer and inner radius, h is the height, and N is the number of windings.

Magnetic Potential Energy: $U^B = \frac{1}{2}LI^2$ (7)

Magnetic Potential Energy Density: $u_B = \frac{1}{2}\frac{B^2}{\mu_0}$ (8)

Chapter 30

EM Waves: $E(z,t) = E_0 \sin(kz - \omega t)\hat{\imath}$ and $B(z,t) = B_0 \sin(kz - \omega t)\hat{\jmath}$ (9)

Poynting Vector: $\vec{S} = \frac{1}{\mu_0}\vec{E} \times \vec{B}$, $S_{\text{av}} = \frac{1}{\mu_0}E_{\text{rms}}B_{\text{rms}}$ (10)

Electromagnetic Wave Power: $P = \iint \vec{S} \cdot d\vec{A}$ (11)

Speed of Light: $c = \frac{E_0}{B_0} = \frac{1}{\sqrt{\epsilon_0\mu_0\kappa}} = 3.0 \cdot 10^8$ m/s (12)

Root Mean Squared: $E_{\text{rms}}^2 = \frac{1}{2}E_{\text{max}}^2$ and $B_{\text{rms}}^2 = \frac{1}{2}B_{\text{max}}^2$ (13)

Electromagnetic Energy Density in a wave: $u = \frac{1}{2}\epsilon_0 E^2 = \frac{1}{2}\frac{B^2}{\mu_0} = \sqrt{\frac{\epsilon_0}{\mu_0}}EB$ (14)