

# Physics Quiz 3 Formulas

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

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

$$\text{Electric field of Parallel Plates: } E = \frac{q}{\epsilon_0 A}$$

## Maxwell's Equations

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

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

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

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

## Chapter 29

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

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

$$\text{Magnetic Potential Energy: } U^B = \frac{1}{2} L I^2 \quad (7)$$

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

## Chapter 30

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

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

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

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

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

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