Equation Sheet for Exam 3

Magnetic forces

- The Lorentz force is \( \mathbf{F} = q \mathbf{v} \times \mathbf{B} \). The direction is determined by the right-hand rule.

- Combined electric and magnetic forces, \( \mathbf{F} = q \mathbf{E} + q \mathbf{v} \times \mathbf{B} \).

- The magnetic force on a current carrying wire is \( \mathbf{F} = I \times \mathbf{B} \).

- The cyclotron equation. For a charged particle moving on a circle in a uniform magnetic field, \( \frac{mv^2}{r} = qvB \).

Ampere’s Law

- The magnetic field due to a long straight current carrying wire is \( \mathbf{B} = \frac{\mu_0 I}{2\pi r} \).

- The magnetic field in a solenoid is \( \mathbf{B} = \frac{\mu_0 N I}{L} \).

- The magnetic constant is \( \mu_0 = 4\pi \times 10^{-7} \text{ Tm/A} \).

Faraday’s Law

- Faraday’s law of electromagnetic induction: \( \mathcal{E} = -\frac{\Delta \Phi}{\Delta t} \), where \( \mathcal{E} \) = electromotive force around a loop, and \( \Phi \) = the magnetic flux through any surface bounded by the loop; \( \Phi = B A_{\text{perp}} = B A \cos \theta \).

- Transformer equations \( \frac{V_2}{N_2} = \frac{V_1}{N_1} \) and \( I_1V_1 = I_2V_2 \).

Light

- Snell’s law: \( n_1 \sin \theta_1 = n_2 \sin \theta_2 \).

- The index of refraction is \( n = c/v \).

- \( c = 2.998 \times 10^8 \text{ m/s} \)

- \( \lambda f = c \)

- \( I = \frac{P}{4\pi r^2} \)

Other information

- Proton mass = \( 1.67 \times 10^{-27} \text{ kg} \)

- Proton charge = \( e = 1.60 \times 10^{-19} \text{ C} \)