

Study Guide for Midterm 1 for Algebra-Based Physics-2: Electricity, Magnetism, and Modern Physics (PHYS135B-01)

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1. **Applications of circuits, Chapter 21:** (Recall that $P = iV$, $V = iR$, and that two resistors in parallel combine like $R_{tot}^{-1} = R_1^{-1} + R_2^{-1}$.)

- (a) A 250 W space heater, a 1000 W microwave, and a 50 W coffee pot are connected to the 120 V outlet. Will this blow the 12 amp fuse?
- (b) A 200 W toaster, a 1000 W microwave, and a 250 W mini-fridge are connected to the 120 V outlet. Will this blow the 12 amp fuse?

Suppose the mini-fridge in the previous problem were disconnected.

- i. What would the current be?
- ii. What would be the total effective resistance?
- iii. What are the resistances of the separate devices?

2. **Magnetism, Chapter 22:** Recall the form of the Lorentz force is $\vec{F} = q\vec{v} \times \vec{B}$, and that centripetal force is $F = mv^2/r$.

- (a) Draw the magnetic field of the Earth, and indicate the trajectory of a positively charged particle from space that enters this field. Draw a trajectory for a negatively charged particle.
- (b) Suppose a positively charged particle has a velocity of $\vec{v} = v_0\hat{i}$, and that it moves through a uniform magnetic field $\vec{B} = B_0\hat{j}$. In which direction does the particle accelerate?
- (c) Suppose a positively charged particle has a velocity of $\vec{v} = v_0\hat{i}$, and that it moves through a uniform magnetic field $\vec{B} = B_0\hat{k}$. In which direction does the particle accelerate?

(d) Suppose a charged particle with charge q , mass m and velocity $\vec{v} = 2 \times 10^8 \hat{x}$ m/s moves in a circle with radius 1.0 m through a magnetic field $\vec{B} = 10^{-3} \hat{y}$ T. What is the charge-to-mass ratio q/m ?

(e) Suppose we use an electric field to determine that the charge of these particles is positive and twice that of a proton ($q = 2 \times 1.6 \times 10^{-19}$ C). What is the mass of these particles?

3. **Magnetism 2, Chapter 23:** Recall that the definition of magnetic flux through an area A by a B-field B is $\phi = \vec{B} \cdot \vec{A} = BA \cos \theta$. Recall also Faraday's law $\text{emf} = -N \Delta \phi / \Delta t$, and that $\mu_0 = 4\pi \times 10^{-7}$ T A⁻¹ m.

(a) Suppose a loop of wire has an area A and is in the x-y plane ($\vec{A} = A\hat{k}$). A magnetic field \vec{B} creates a flux ϕ through the loop of wire. Create a graph of ϕ versus θ , where θ is the angle between the field and the loop. Indicate on the graph the angles at which the flux is maximal and where it is zero.

(b) If $|B| = 10^{-2}$ T, and A is 4 cm², what is the maximum ϕ ?

(c) If the magnetic field reduces to 0.0 T in 4 ms, what emf is induced in the wire? (Assume $\theta = 0$).

(d) Suppose a solenoid shaped wire has $N = 1000$ coils, and is $L = 4$ cm long. Suppose we feed a current $I = 1.0$ amp through the solenoid. Ampère's Law tells us that the magnetic field in the solenoid is $B = \mu_0(N/L)I$. What is the magnetic field in this situation?