Study Guide for Midterm 2 for Algebra-Based Physics: Electricity and Magnetism

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1 Equations and constants

1. Kirchhoff's Rules: 1) $I_{in} + I_{out} = 0$ (Junction Rule) 2) $\sum_{loop} V_i = 0$ (Loop Rule)
2. Ohm's Law: $V = IR$
3. Power from current: $P = IV$
4. Voltage in an RC across the capacitor: $V(t) = \epsilon\left(1 - \exp\left(-t/\tau\right)\right)$, where ϵ is the battery voltage and $\tau = RC$.
5. Centripetal force: $F_C = mv^2/r$.
6. Magnetic torque: $\vec{\tau}_B = \vec{\mu} \times \vec{B}$
7. Magnitude of torque: $|\vec{\tau}_B| = \mu B \sin\theta$
8. Magnetic dipole moment: $\vec{\mu} = I\vec{A}$ (the current times the area vector)
9. Magnetic field at the center of a current-carrying loop: $\vec{B} = (\mu_0 I)/(2R)\hat{z}$, if the current is in the x-y plane.
10. Magnetic field due to a current-carrying wire at a distance R: $B = (\mu_0 I)/(2\pi R)$, right-hand rule gives direction.
11. Ampere's Law: $\int \vec{B} \cdot d\vec{s} = \mu_0 I_{enc}$ which is $BS = \mu_0 I_{enc}$ for simple cases where B is constant around the path.
12. Magnetic permeability: $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}
13. The Hall Effect: $V_H = Blv$.

2 Exercises

1. **Review Problem (similar exercise on the final)**

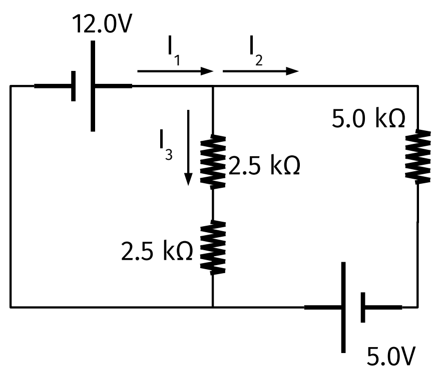

Figure 1: A circuit with three resistors.

   (a) Solve for the currents I_1-I_3 in Fig. 1.
   $I_3 = 12/5$ mA, $I_2 = 17/5$ mA, and $I_1 = 29/5$ mA.

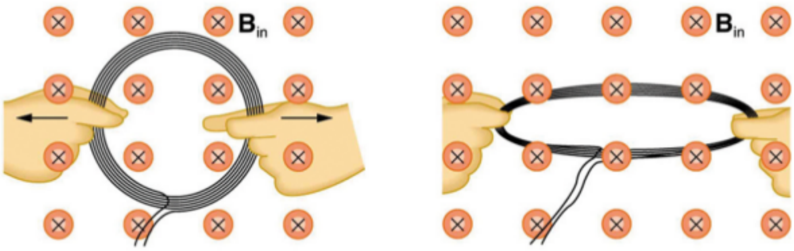

Figure 2: (Left) A magnetic field passes through loops of wire. (Right) The loops are stretched, reducing the area.

2. **Chapter 23: Magnetic Induction, Faraday's Law, and AC power**

   (a) In Fig. 2 (left) a uniform magnetic field passes through loops of wire. In Fig. 2 (right) the **area** of the loops is reduced by stretching the loops. Which of the following is true?

   - A: No current flows through the wires.
   - B: Current does flow through the wires, but there is no induced emf in the wires.
   - C: Current flows through the wires, because the induced emf is caused by a change in electric flux.
   - D: Current flows through the wires, because the induced emf is caused by a change in magnetic flux.

   (*The answer is D. Magnetic flux $\phi = \vec{B} \cdot \vec{A} = BA$ in this case. If the area changes, so does the flux.*