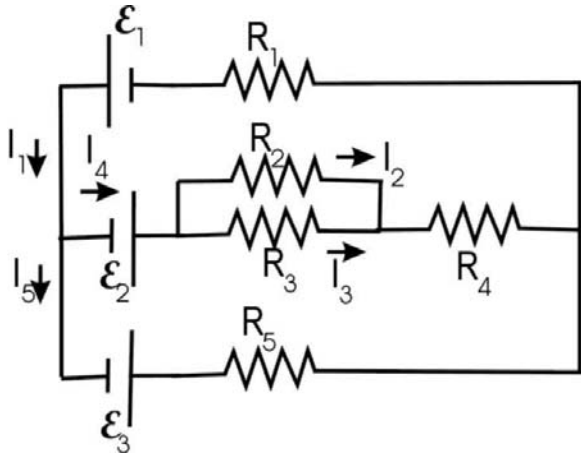


Physics 9HD, Practice Problems for Midterm 2 (covering Chapters 4-6, Problem Sets 5-7)

- Consider the following circuit with known emf's (voltages)  $\mathcal{E}_1$ ,  $\mathcal{E}_2$ , and  $\mathcal{E}_3$ , and known resistances  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$ ,  $R_5$ . The unknown currents  $I_1$  through  $I_5$  are defined in the diagram.
  - First find the equivalent resistance,  $R_{eq}$ , for the combination of  $R_2$ ,  $R_3$ , and  $R_4$  as shown.
  - Using  $R_{eq}$  in place of  $R_2$ ,  $R_3$ , and  $R_4$ , write a set of 3 equations which could be solved for  $I_1$ ,  $I_4$ , and  $I_5$ . (You do not need to actually solve for  $I_1$ ,  $I_4$ , and  $I_5$ .)
  - Now assuming that  $I_4$  is known, explain how you would find  $I_2$  and  $I_3$ .



- An electron is moving with initial velocity of  $3 \times 10^8$  cm/sec at an angle of  $30^\circ$  with respect to a constant magnetic field of 5000 gauss. What is the force on the electron (magnitude and direction)? Describe the shape of the path of the electron's motion. What is the frequency of the motion? ( $m_e = 9.11 \times 10^{-28}$  g,  $e = -4.8 \times 10^{-10}$  esu =  $-1.6 \times 10^{-19}$  coul)
- Two current carrying wires are parallel for a length of 200 cm and separated by a distance of 2 cm. One has current of 5A and the other of 10A. If the wires are attracted together calculate the magnitude of the force. By determining the direction of the field of one wire at the position of the other and the resulting attractive force, explain whether the currents are in the same or opposite directions.
- Use the Biot-Savart Law to calculate the  $\vec{B}$  field at distance  $r$  from an infinitely long wire carrying current  $I$ . Show that the results agree with what you expect from Ampere's Law.  
(Note  $\int \frac{y dx}{(x^2 + y^2)^{3/2}} = \frac{x}{y \sqrt{x^2 + y^2}}$ )
- Use Ampere's law to calculate the field both inside and outside an infinitely long wire carrying current density  $\vec{J} = Ar^2$ , for  $0 \leq r \leq a$  where  $A$  is a constant, and  $r$  is the cylindrical radial coordinate, and  $a$  is the radius of the wire.
- (a) Suppose a capacitor with plates parallel to the  $xy$  plane, plate dimensions of dimensions of 10 cm x 10 cm, and separation 1 cm is charged to 100V in frame  $F$ . Find the  $\vec{E}$  field and the charge density  $\sigma$  both in frame  $F$  and in frame  $F'$  which is traveling at speed  $\vec{v} = 0.6c \hat{x}$  with respect to  $F$ .  
(b) Answer the same question if the capacitor plates are originally oriented parallel to the  $yz$  plane in frame  $F$ .
- Find the maximum  $\vec{E}$  field from an electron moving at speed  $0.8c$  approaching along the  $x$ -axis, as measured in the lab at  $(0, 0.01\text{cm}, 0)$ . If a proton is located in the lab at this position, what is the force on the proton? Make a rough sketch of the field lines of the traveling electron, as observed in the lab frame.