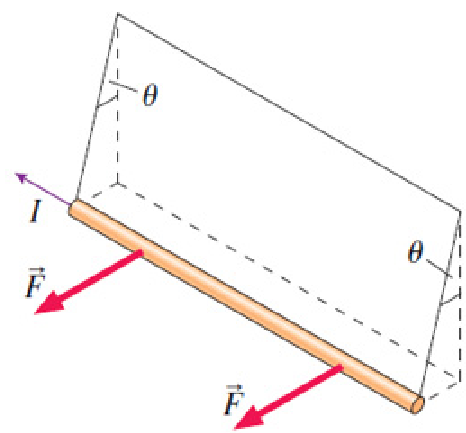
Assignment VII, HONS 158 (Honors Physics II)
Spring 2016
Due 3/2/16 at start of class

As always, please put your answers on separate paper.

1. A charge of $+4.1\ \mu$C moves with velocity $3\text{ m/s}\hat{\imath} + 2\text{ m/s}\hat{\jmath} - 4\text{ m/s}\hat{k}$ through a magnetic field $\vec{B} = 324\text{ G}\hat{\imath} - 519\text{ G}\hat{\jmath} + 79\text{ G}\hat{k}$. What is the total force on the charge? (Leave your answer in components).

2. Two power lines, each 3 km in length, run parallel to each other with a separation of 20 cm. If the lines each carry a current of 10 kA, what are the magnitude and direction of the magnetic force each exerts on the other? (The current is running the same direction in both power lines).

3. A metal bar of mass m and length L is suspended from two conducting wires. A uniform magnetic field points vertically downward. Find the angle θ the suspending wires make with the vertical when the bar carries current I.



4. You create a solenoid 14 cm long with a total of 829 turns. The solenoid is designed to cancel the Earth's magnetic field of 0.5 Gauss. What current do you have to run through the solenoid to cancel this current?

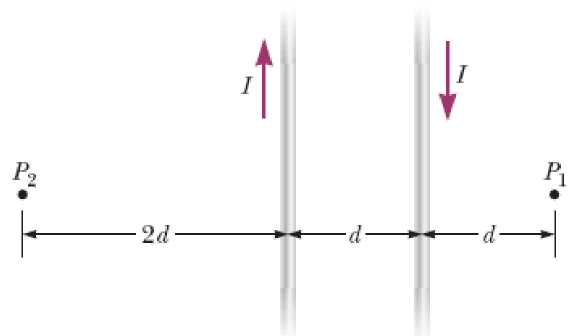
5. To construct a solenoid, you wrap insulated wire uniformly around a paper-towel tube. (Paper towel-tubes are pretty standard at 11 inches long; you may assume the tube has a diameter of 1.6 inches). You have the ability to generate a 1.3 A current and want to produce a 0.25 T magnetic field inside the solenoid. How much total wire do you need to generate this magnetic field? (You may assume the wire is thin enough that you can put it on in one layer on the outside of the tube).

6. Two wires each carry current I (but in opposite directions). The distance between the wires is d as shown. Points P_1 and P_2 are two points in space where you desire to know the total magnetic field.

   a) What is the total magnetic field at point P_1, located a distance d to the right of the rightmost wire?

   b) What is the total magnetic field at point P_2, located a distance $2d$ to the left of the leftmost wire?

   c) If the current in the left wire had magnitude $3I$ instead of I, find all places that the magnetic field vanishes. (For uniformity in answers, let's use P_2 as the origin and, thus, $P_1 = 4d\hat{i}$.)



7. You have a circular conducting loop of wire of length L in a uniform magnetic field of intensity $B_\circ$. The surface normal of the wire is parallel to the magnetic field (to maximize the magnetic flux). The loop is suddenly changed from a circular to a square shape.

   a) This change in shape induces a current in the wire. Explain why.

   b) What is the change in magnetic flux through the wire if $B_\circ = 0.45$ T and $L = 1.5$ m.

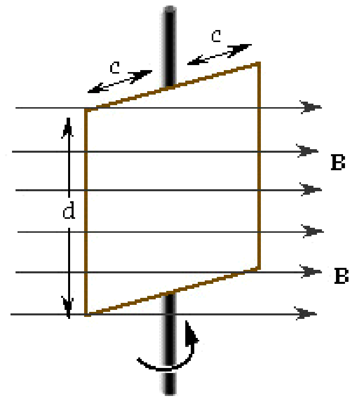
   c) What is the emf generated in the loop if the change occurs during 0.3 seconds?

   d) Lets say that instead of a single circular loop, you had a double-loop. (E.g. with your wire of length L you formed two circles each with perimeter $L/2$, both running current clockwise when viewed from above). You then take this double-loop and change it into a double-square loop. What is now the change in magnetic flux through the wire if $B - \circ = 0.45$ T and $L = 1.5$ m?

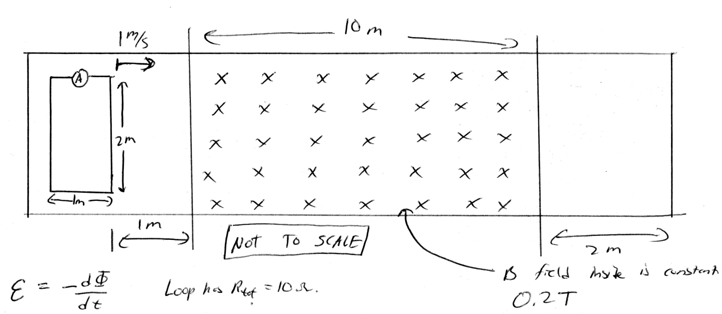
8. A copper penny is placed on edge in the powerful magnetic field of an MRI. If the penny is tipped over, it takes a few seconds for it to land, almost as if it is falling in slow motion. Explain why.

9. Do problem 18 in Chapter 30 of your text.

10. A loop is rotated in the presence of a constant magnetic field B as shown. Assume that at time $t = 0$, the loop is aligned so that the magnetic flux through the loop is maximized. Assume that the loop turns as shown and that the period associated with one full rotation is T. The resistance of the loop is R. In terms of T, B, c, d, R, and/or fundamental constants, write an expression for $I(t)$ (the current in the loop as a function of time).



11. Examine the figure below. The loop of wire is moved with a steady velocity of 1 m/s to the right.



a) Draw a sketch of the enclosed flux (Φ_B) in the loop as a function of time. Make sure to carefully identify any important values on your axes.

b) Draw a plot of the induced current as a function of time. Let "clockwise" conventional current be defined as positive and let "counterclockwise" current be defined as negative. Take care to plot any important values. Assume your ammeter responds instantaneously, and note that the loop has a total resistance of 5 Ω (not the 10 Ω that the figure suggests).