Assignment VII, PHYS 112 (General Physics II)
Fall 2020
Due via pdf upload to OAKS prior to Friday, October 16th at 10:00 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units.

Since several people in class asked for this, here are some suggested (but ungraded) extra problems from the textbook for practice: (All problems out of Halliday, Resnick, and Walker, 10th Extended Edition, "Fundamentals of Physics"). (I chose all odd-numbered problems since the answers to those problems are in the back of the book and that's a good way to check if your practice is accurate.) No need to turn these in, but if you are looking for extra things you can work on if you want to practice problem solving some more, here's what I would advise.

Chapter 28, problems 39, 41, 43, 45, 51, 71, 75, 77, 81, 85
Chapter 29, problems 1, 3, 9, 19, 23, 29, 49, 51, 53, 65, 71, 79
Chapter 30, problems 3, 5, 9, 13, 17

1. The Earth's magnetic field varies a little bit over its surface, but it is generally between about 0.2 Gauss and 0.6 Gauss. Let's use a value of 0.4 Gauss as a typical value. A transmission line is designed to transport, say, 10 kA of current. For simplicity, we will assume this is DC current.

   a) How far away would you have to be from the center of this transmission line so that the strength of the magnetic field generated by the transmission line is equal to the Earth's magnetic field?

   b) How close would you have to be to this transmission line to experience the same magnetic field associated with an MRI scan (about 1.5 Tesla)?

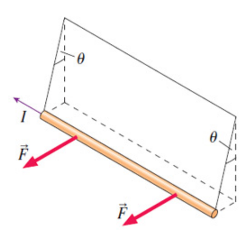
2. The strength of the magnetic field in the center of a current loop is equal to $B = \frac{\mu_0 I}{2r}$ (as we may have already mentioned in class). For the sake of this problem, let's treat a Hydrogen atom as a single, stationary proton with an electron orbiting it in a circular orbit. (We'll find out later this semester that this is a bit nuts....but for now we'll stick with this picture).

   a) Assume that your electron (with a mass of 9.11×10^{-31} kg and a charge of 1.602×10^{-19} C) is in uniform circular motion with the associated centripetal force being supplied by the Coulomb attraction between the proton and the electron. We will assume that the electron is in a stable circular motion a distance 5.3×10^{-11} meters from the proton. What, then, must be the speed of the electron? (You'll have to think back to last semester).
   b) If we think of it, we now can write the associated "current" for an electron orbiting a proton; this would be the total charge that moves divided by the time it takes to complete a full circuit. You have all the information to find this, so identify the "current" for a single electron orbiting a proton.
   c) This "current" would induce a magnetic field at the center of the atom. What is the magnitude of this magnetic field?

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

4. 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).

5. 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.



6. 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?

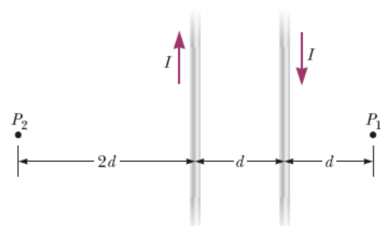
7. To construct a solenoid, you wrap insulated wire uniformly around a paper-towel tube. (Paper towel-tubes are pretty standard at 11 inches long; you may assume the tube has a diameter of 1.6 inches). You have the ability to generate a 1.3 A current and want to produce a 0.25 T magnetic field inside 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).

8. 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, $P_1 = 4d\hat{i}$.)



9. You have a circular conducting loop of wire of length L in a uniform magnetic field of intensity B . 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 = 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 = 0:45 T and L = 1:5 m?