PHY1308 - Homework 9

Expectations for the quality of your handed-in homework are available at http://www.physics.smu.edu/sekula/phy1308/homework.pdf. Failure to meet these guidelines will result in loss of points as detailed in that document. **This assignment is due on Tuesday, April 12 by 9:30am.**

Reading Assignment

- Chapter 26.8-27.3

Practice Problems

These are not required; they are odd-numbered problems from Wolfson that may help you to warm up for the required problems.

- CH26-41
- CH27-17

A Note on Significant Figures

Wolfson's representation of numbers can often make interpreting the number of significant figures very difficult. Here are some rules you can follow and to which the solutions will adhere:

1. If an integer number has a trailing zero (e.g. 50 or 100), but no decimal point to indicate that zero is significant, TREAT THE TRAILING ZEROS AS SIGNIFICANT.
   a) Example: 100 will have three significant figures. 50 will have two.
2. If an integer less than 10 is given, assume it is INFINITELY SIGNIFICANT
   a) Example: 2 has infinite precision, and should be treated like 2.0000000...

Required Problems

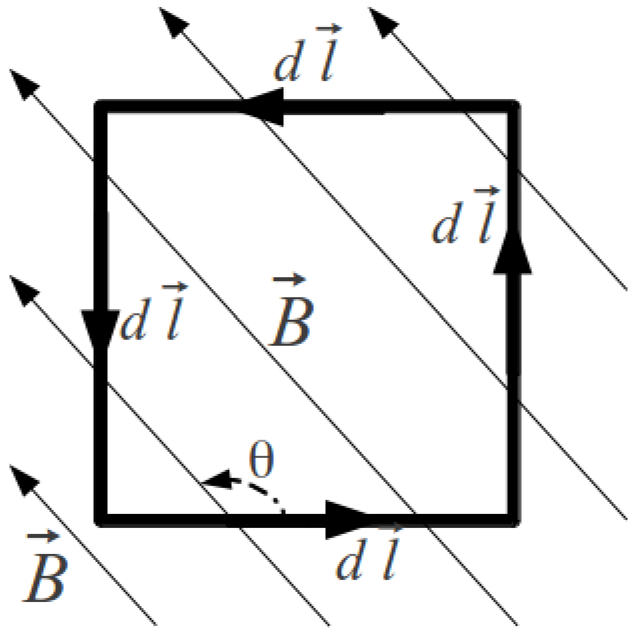
- SS-16 [30 Points]
- SS-17 (see below) [35 Points]

Problem SS-16: Applying Ampere's Law

Part (a): You find that the line integral of a magnetic field on a closed path surrounding a wire has the value of 14.6 μT·m. What is the current flowing in the wire?

Part (b): The magnetic field inside of a uniform cylindrical current (whose outer radius is R=0.50cm) is determined to have a magnitude of B=1.0mT at a radius of r=0.10cm. What is the current density?

Part (c): Solve for the line integral of the path shown below. The path is a square whose sides are length L=0.50m. The uniform magnetic field has a magnitude of B=0.25mT. The angle, θ, shown below between the bottom of the path and the magnetic field is θ = 2.09 radians. Based on your solution, determine the current enclosed by the closed path.



Problem SS-17: Death Magnetic?

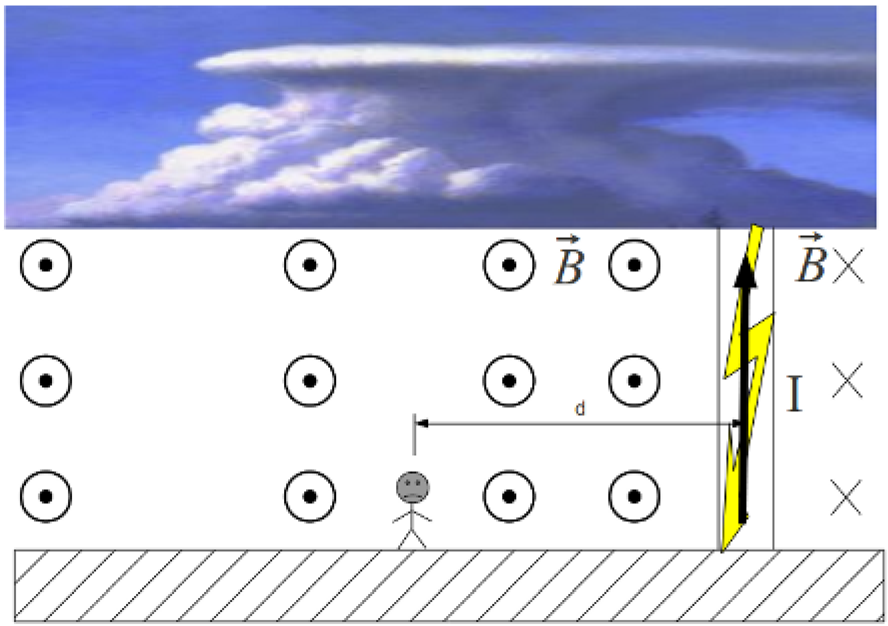
Lightning strikes *near* people, but not directly *on* them, have been known to kill. One hypothesis is that the magnetic fields from a lightning strike disrupt the flow of electrical current inside the heart, and induce a heart attack.

Part (a): A lightning bolt is essentially a long, straight, narrow cylinder of electrical current flowing from the ground to the sky (remember that current flows in the direction of positive charge and opposite the direction of negative charge; since electrons come from the sky to the ground during a strike, current flows UPWARD). If such a lightning bolt has a maximum current of 250.0kA, what is the magnetic field strength 50.0 meters from the lightning strike when the current reaches its maximum?

Part (b): You (and your heart) are standing 50.0m from such a lightning strike. Assume that the magnetic field from the lightning strike is uniform across the heart. At maximum current, what is the magnetic flux through a circular cross-section of the heart with radius 5.0cm whose normal vector, $\vec{A}$, is parallel to the magnetic field lines?

Part (c): In order to disrupt the heart's electrical processes, the magnetic field from a lightning strike must be strong enough to induce electric currents in the heart with a magnitude of at least 100mA. If the current in the lightning bolt increases steadily from 0kA to 250.0kA over a period of 0.20s, and the heart is as described in part (b), how far from the lightning strike do you have to be in order for a 100mA current to be induced in the heart? The typical resistance of heart tissue is about 100.0Ω.

Part (d): Does this magnetic field hypothesis seems like a plausible explanation for indirect death from a lightning bolt?



Zoom in on the heart: