General Physics - E&M (PHY 1308) Lecture Notes

Homework010

SteveSekula, 3 November 2010 (created 31 October 2010)

no tags

Homework 10

Expectations for the quality of your handed-in homework are available at http://www.physics.smu.edu/sekula/phy1308/HomeworkPolicy.pdf. Failure to meet these guidelines will result in loss of points as detailed in that document. This assignment covers material from Wolfson Chapter 26 and 27.

The total assignment is worth 80 points.

This homework is due by 5pm on Monday, November 8 (place in my mailbox in Fondren Science 102)

Reading Assignment:

Chapter 26, 27.1-27.2

Required Problems from Wolfson and Sekula

These are **required problems that are part of the official homework assignment.**

- CH26-40 (10 Points)
- CH26-44 (10 Points)
- CH26-76 (20 Points)
- CH27-16 (20 Points)

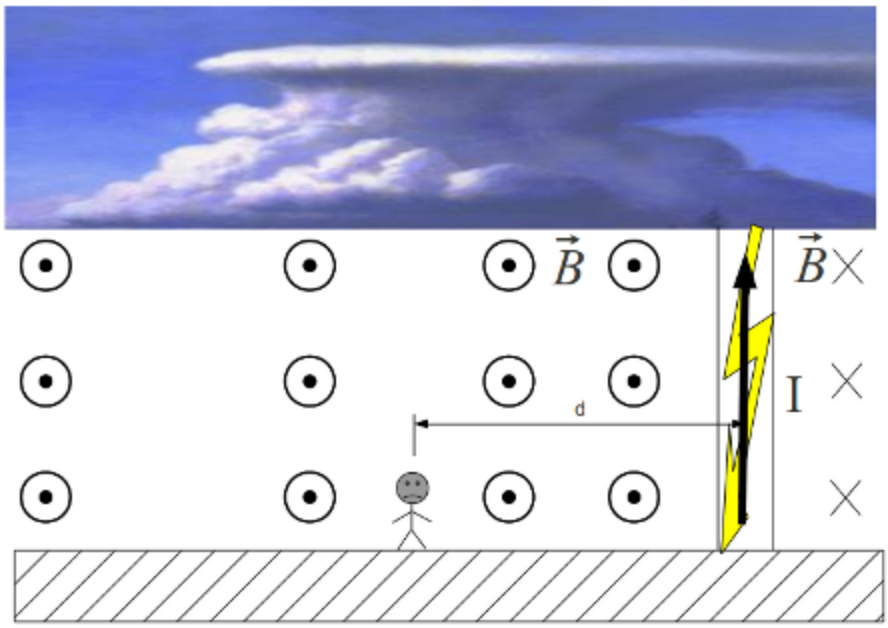
SS-16: Death Magnetic (20 Points)

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

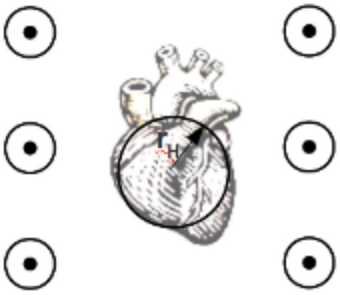
Part (a): A lightning bolt is essentially a long, straight cylinder of electrical current flowing from the ground to the sky (remember that current flows in the direction of positive charge and opposite the direction of negative charge; since electrons come from the sky to the ground during a strike, current flows UPWARD). If such a lightning bolt has a current of 250.0kA, what are the magnetic field strengths at 1.0m, 10.0m, and 100.0m from the lightning strike?

Part (b): In order to disrupt the heart's electrical processes, the magnetic field from a lightning strike must be strong enough to induce stray currents in the heart with a magnitude of at least 100mA. The lighting strike creates a magnetic field that appears suddenly (over a period of about 0.15s); this induces a changing magnetic flux through the cross-sectional area of the heart (which we can treat as a circular area of radius 5.0cm). Assume that a normal to the area of the heart is parallel to the magnetic field. Assume also that the magnetic field is uniform across the heart, with a magnitude calculated using the distance of the person from the lightning strike. If the typical resistance of heart tissue is about 100.0Ω, how far from the lightning strike do you have to be in order for a 100mA current to be induced in the heart?

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



Zoom in on the heart:



Optional Warm-Up Problems from Wolfson

These are not required but are meant to help you warm up to the problems that are required. They are odd numbered, and solutions to the odd-numbered problems are available in the back of the book and fully detailed in the student solution manual.

- CH26-41
- CH27-17