

HW11 Concepts

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1 28.20 Two Hikers

Here you are given the parameters for a transmission line, both its height above the ground and the current it is carrying. The point of the problem is to estimate the effect this line will have on the hiker's compass. Compare this field with that of the Earth's. How does it compare? How near to the wire would you have to be to cause interference? How is your answer affected by the fact that power lines usually come in pairs which are separated by 1 meter?

2 28.27 Lamp Cord Wires

You are given some parameters for lamp cord, and given the specs for the light bulb that they power. Then you are told to calculate the force between the wires. Is it attractive or repulsive? Is there a way to switch the direction the force acts? For what sort of currents will the force be large enough to be considered during the cord design? How do these required currents compare to the maximum currents that household wire gauges can carry? Note: Your circuit breaker is usually designed to trip on 15 or 20 amps.

3 28.42 Solenoid Design

You are given some basic specs for the design of a solenoid. If you use the solenoid equation from the book, make sure you understand where the equation comes from. Think about how it scales in each of its arguments? Does this scaling make sense? You can also take this time to think about how a finite

solenoid differs from an infinite one. Can you derive an expression for the magnetic field along the axis of a finite solenoid as a function of the distance?

4 2 Wires

You are led in steps to deriving the magnetic field along the y axis as a function of y for a system of two wires. How does your expression change if the direction of the current in one of the wires is reversed? When it comes time to graph the field magnitude as a function of y , take the time to see if you can sketch the graph without using a graphing calculator of some sort. Sketching graphs is an important skill to develop. In the last few parts you are led to compute the magnitude of this field at the location where it is maximum for some physical values and told to compare this to the Earth's magnetic field. Are these current parameters reasonable? How strong is the Earth's magnetic field?

5 Wire & Loop

You are told to consider a system composed of an infinitely long wire and a closed loop. You are told to compute the net force on the loop due to the wire. What is the net force on the wire due to the loop? Could you use this information to calculate the magnetic field due to the loop? Is the force of the wire on the loop attractive or repulsive? Could this have been suspected? Then you are told to compute the force on each wire segment due to the other three segments in the loop. Is there a net force? Was this to be expected? Regardless of whether or not there is a

net force, can the forces act to try to disturb the loop in some way? If I were to make the loop out of some flexible wire, would running a large current through the wire cause it to deform? Into what shape in particular? Finally you are told to calculate the force due to the wire and balance this against the gravitational force. Is this equilibrium stable or unstable? How can you tell? Can a system like this be used to levitate a loop?

6 Hairpin Circuit

You are told to calculate the magnetic field at the center of the curve of a hairpin wire configuration. The hint suggests that you can figure this out without working from scratch using the results of a loop and a straight wire and some symmetry type arguments. Make sure you reason this argument out in detail, arguments like this are crucial to solving hard problems. Even though you don't need to figure out the magnetic field from scratch, do you know how this would be done? If you have the time and inclination, this might be a good time to attempt to derive a magnetic field from scratch using the Biot Savart Law.