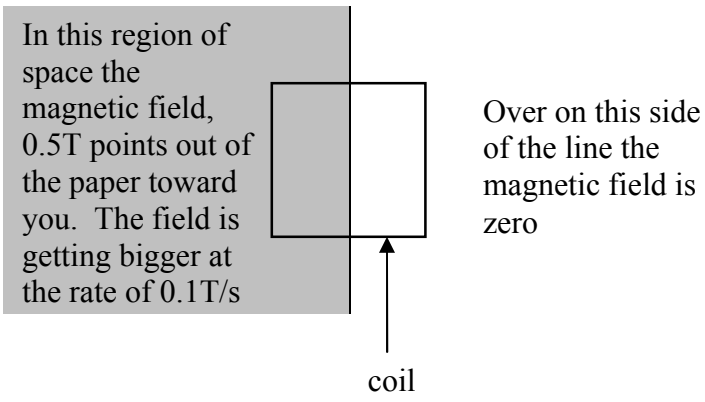
Practice Problems for Exam #3

1. I have a coil of wire hooked to a current meter. The coil is in front of me. I am holding a magnet with the north pole pointing toward the coil. If I move the magnet rapidly toward the coil I see the needle on the current meter move to the left. Which direction will the needle move if I start the magnet near to the coil (still on my side) with the south pole pointing toward the coil and pull the magnet toward me?

2. I have a square coil of wire (10cm on a side) with three turn in it. It sits flat on top of this piece of paper. There is a magnetic field that points straight up out of the paper – it's strength is 2T. The size of the magnetic field is decreasing and it will be zero it 10 seconds. If the coil of wire has a resistance of 60Ω, what is the size and direction of the current in the bottom of the coil?

3. I have a square coil of wire (8cm on a side) with only one turn in it. One half of it is in a region of space where there is a magnetic field of 0.5T and the other half is in a region where there is no field. See the picture. The resistance of the coil is 3.2Ω and the mass of the coil 0.2g. If the field begins to increase at the rate of 0.1T/s, what is size and direction of the acceleration of the coil? This is your hardest problem. Take it one step at a time.
    a. Why does anything accelerate?
    b. What force will there be?
    c. What do you need to find the force?
    d. Why does a current flow in the wire?
    e. How do you find the size of the current?
    f. How do you find the direction of the force?
    g. How do you find the direction of the current?



4. A magnet with the north pole down is falling toward (and would then pass through) a copper ring. Draw a picture and write no more than 30 words to explain why it falls more slowly than it would in the absence of the ring.

5. I wish to convert 2000Volt AC current into 120Volt current. I want to build a transformer to accomplish this. On the 120Volt side of the transformer I will have 240 turns of wire. How many will I need to have on the 2000Volt side?

6. You have a choice to run a transmission line at 40,000Volts or at 80,000Volts. The wire has a resistance of 10Ω. Suppose that you want to transmit one million watts of power down this line. How much power would you lose to heating the transmission line itself in each case? Be careful! The 40,000Volts or 80,000Volts is the potential difference between the line and the ground – not the difference between one end of the line and the other. How do you work the one million watts into the problem?

7. At a particular moment, the current in an RL circuit is 1.0A. The battery voltage is 15.0Volts and the resistance is 10.0Ω. If the size of the inductor is 0.50H, at what rate is the current changing (what is the size of $\Delta I/\Delta t$)?

8. In problem 7, how much energy is stored in the inductor?

9. In problem 7, how much time had passed since the switch was closed and the current had started to flow?

10. Suppose that you had an inductor and a capacitor put together in parallel. What would the resistance be like at very low frequencies? What would it be like at very high frequencies? What do you guess it would be doing in between?

11. A lightwave has an electric field amplitude of 100V/m. What is the average intensity of the wave?

12. In problem 11, how much time is required for 10J of energy to pass through a hole with an area of $10^{-4}m^2$. (Ask yourself what intensity is.)

13. In problem 11, what is the force exerted on a $0.2m^2$ area by the light wave if it is absorbed? (It is a very small number.)

1. Left
2. 0.0001A to the right
3. $0.02 m/s^2$ to the right
4. Look to your class notes when we discussed the magnet falling through the copper tube.
5. 4000 turns of wire
6. 6250W for 40,000Volts or 1563W for 80,000Volts
7. 10A/s
8. 0.25J
9. 0.55s
10. At very low frequencies the inductor would have a very low resistance so the parallel combination will have a very small resistance, $f \cdot L$, (the current all goes through the inductor). At very high frequencies the capacitor has a very low resistance, $1/(f \cdot C)$, and the parallel combination will again have a very small resistance. At medium frequencies I would expect the resistance gets larger as neither component will have an especially small resistance.
11. $13.3 W/m^2$
12. 7,520s
13. $8.9 \cdot 10^{-9} N$