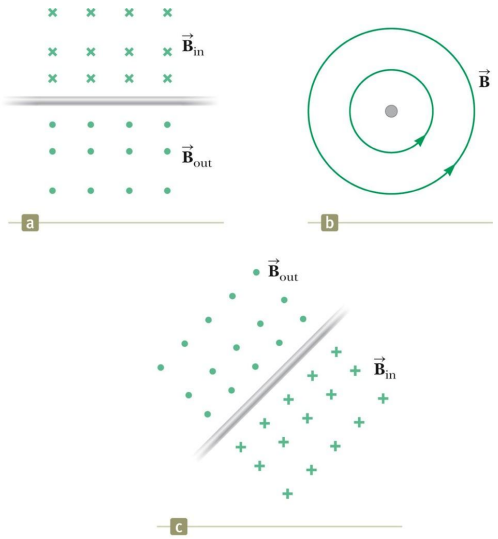
University Physics II

Homework Set 9

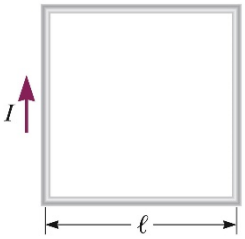
1. ** For each of the below configurations, find the direction of the current in the wire that would produce a magnetic field directed as shown.



2. Calculate the magnitude of the magnetic field at a point 25.0 *cm* from a long, thin conductor carrying a current of 2.00 A.

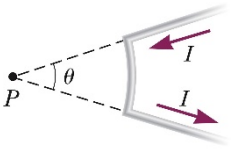
3. In Niels Bohr's 1913 model of the hydrogen atom, the electron orbits a proton in circular orbits with a radius of 5.29×10^{-11} m at a speed of 2.19×10^{6} *m/s*. Compute the magnitude of the magnetic field this motion produces at the location of the proton.

4. A conducting loop in the shape of a square with an edge length $l = 0.400$ *m* carries a current $I = 10.0$ A as shown in the figure at right.

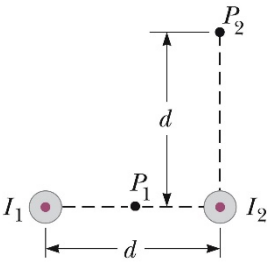


   a. Calculate the magnitude and direction of *B* at the center of the square loop.
   b. Assume this conductor is reshaped into a circular loop in which the circumference equals $4l$ and carries the same current. Calculate the magnitude and direction of *B* at the center of the circular loop.

5. A current path shaped as shown in the figure at right produces a magnetic field at *P*, the center of the circular arc. If the arc subtends an angle $\theta = 30.0^{o}$ and the radius of the arc is 0.600 *m*, what are the magnitude and direction of the magnetic field produced at point *P* if the current is 3.00 A?



6. Two long, parallel wires carry currents of $I_1 = 3.00$ A and $I_2 = 5.00$ A in the directions indicated in the figure at right. The wires are separated by a distance $d = 20.0$ *cm.*



   a. Find the magnitude and direction of the magnetic field at point P_1, midway between the wires.
   b. Find the magnitude and direction of the magnetic field at point P_2, located $d = 20.0$ *cm* above I_2.

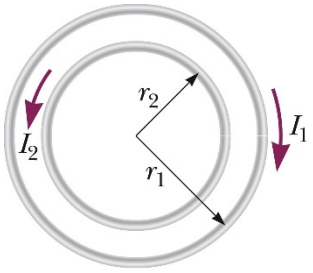
7. Lightning bolts can carry currents up to approximately 20,000 A. We can model such a current as the equivalent of a very long, straight wire.
    a. If you were unfortunate enough to be 5.0 m away from such a lightning bolt when it hit the ground, how large a magnetic field would you experience?
    b. How does this magnetic field compare to one you would experience by being 5.0 cm from a long, straight household current of 10 A?

8. Currents in DC transmission lines can be 100 A or higher. Some people are concerned that the electromagnetic fields from such lines near their homes could pose health dangers. For a line that has a current of 150 A and a height of 8.0 *m* above the ground:
    a. What magnetic field does the line produce at ground level?
    b. How does this compare to the earth's magnetic field (*use* 5.0×10^{-5} T)?
    c. Is there cause for concern? Explain.
    d. Would your answer to part (*c*) change if you considered the magnetic field strength produced at the head-level height of an average person (*use* 1.80 *m*)? Explain.

9. A long solenoid that has 1000 turns uniformly distributed over a length of 0.400 *m* produces a magnetic field of magnitude 1.00×10^{-4} T at its center. Find the current in the solenoid.

10. A certain superconducting magnet in the form of a long solenoid of length 0.500 *m* can generate a magnetic field of 9.00 T in its core when its coils carry a current of 75.0 A. Find the number of turns in the solenoid.

11. Two coplanar and concentric circular loops of wire carry currents of $I_1 = 5.00$ A and $I_2 = 3.00$ A in opposite directions as shown in the figure at right. If $r_1 = 12.0$ *cm* and $r_2 = 9.00$ *cm*,
    a. Find the magnitude and direction of the net magnetic field at the center of the two loops.
    b. Let r_1 remain fixed at 12.0 *cm* and let r_2 be variable. Determine the value of r_2 so that the net magnetic field at the center of the loops is zero.



12. ** You use a tesla meter to measure the magnitude of the magnetic field at various distances from a long, straight, thick cylindrical copper cable of radius R that is carrying a large constant current. To exclude the earth's magnetic field from the experiment, you first set the meter to zero. You then measure the magnetic field *B* at distances *x* from the surface of the cable and obtain the following data:

***x* (*cm*)**	2.0	4.0	6.0	8.0	10.0
***B* (*m*T)**	0.406	0.250	0.181	0.141	0.116

    a. Use the expression for an infinite wire to determine *B* as a function of *x* and *R* for the cable.
    b. Graph the data as *x* vs 1/*B*. Explain why such a plot should yield a straight line by solving your expression found in part (a) for *x*.
    c. Use the trendline from the graph in part (*c*) to determine the current *I* in the cable and the radius *R* of the cable.