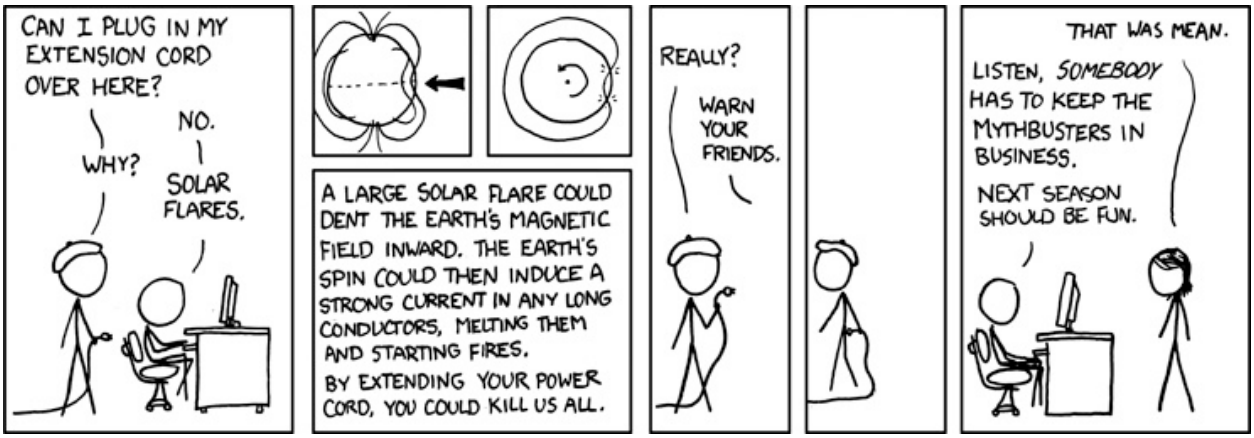
Physics 4L, Spring 2010 — Problem set 10
Due Tuesday April 13 in class

This problem set is short because of midterm 2. Problem set 11 will be longer (including most of the problems on induction) and will get us back on the usual problem set cycle.

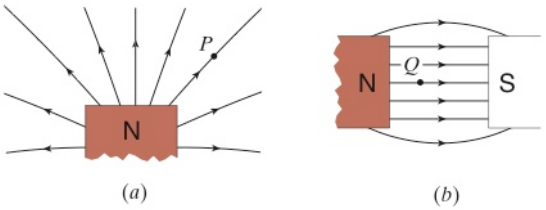


Chapter 26 problem 69, and comment on how your answer illustrates why superconducting solenoids, which have zero resistance, are usually used to produce very strong magnetic fields, such as those needed for NMR measurements and MRI imaging

Chapter 27 problem 82

Additional problems:

1. Consider placing a compass in the magnetic fields shown below. (Field (a) is the field near the north pole of an isolated bar magnet; the magnet also has a south pole which is not shown in the figure.) Sketch the field lines and the orientation of the compass needle at each of points *P* and *Q*, showing clearly the north and south poles of the *needle*. (Remember that the needle of a compass is like a tiny bar magnet; the end of the compass needle that points toward geomagnetic north is a north pole.)



2. Again considering the magnetic fields in problem 1 above: Is there a net force on the compass needle at point *P*? At point *Q*? Explain briefly. If there is a net force, describe the direction of the force.

3. A pair of vertical conducting rods are a distance L apart and are connected at the bottom by a resistor with resistance R. A conducting bar of mass m runs horizontally between the rods and can slide freely down them while maintaining electrical contact. The whole apparatus is in uniform magnetic field B pointing horizontally and perpendicular to the bar. When the bar is released from rest it reaches a constant speed. Find this speed.

Finally, complete the attached worksheet.

1. A magnet is hung by a string and then placed near a wire as shown. When the switch is closed, the magnet rotates such that the ends of the magnet move as indicated by the arrows.

   At the instant the switch is closed determine:

   - the direction of the current through the wire segment nearest the magnet. Explain.