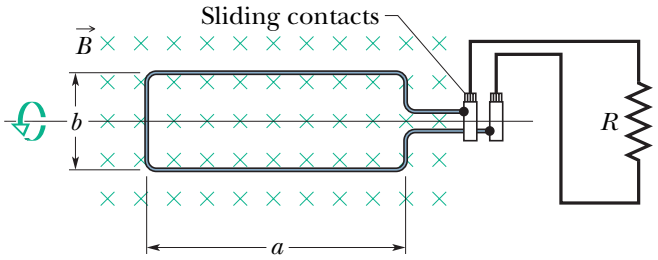
Physics 4B: Collected Homework 4

1. (Faraday's law.) An alternating current generator is constructed from a rectangular coil of wire, length a and width b, with N turns of wire. The coil is in a uniform magnetic field of strength B and will be rotated with a frequency f, at constant angular speed around the axis shown.



   (a) Find an expression for the emf induced in the coil as a function of time.

   (b) The amplitude of the emf is to be 120 V and the frequency $f = 60.0$ Hz. What value of Nab will achieve this if the magnetic field has strength 0.530 T?

   (c) What is the average power delivered to the resistor in this case if $R = 130\ \Omega$?

2. Consider arrangements of n inductors, inductances $L_1,\ L_2, \ldots L_n$. Assuming that all inductors are far enough separated that thee mutual inductance between any pair of the inductors can be taken to be zero, find the equivalent inductance L_{eq} of the inductor arrangement when the inductors are

   (a) all in series and

   (b) all in parallel.

   (c) Now consider just two inductors in series, with inductances L_1 and L_2, but now they are close together on a single circuit board, so their mutual inductance is M. In this case, what is the equivalent inductance L_{eq} of the two inductors together? (For the parallel case, see problem 83 in the textbook.)

3. What is the inductance of a pair of long parallel wires, each of length ℓ and radius R, running side by side at separation d? (Assume $d \gg R$, meaning R is small and you do not have to consider any magnetic field inside the wires, just the field outside of them.) Assume that they each carry a current I, but in opposite directions. (One of the wires is the outward path for the current and the other is the return path.)