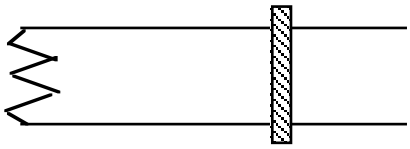
Physics 132
General Physics II
Grinnell College

Homework XIa

Session XI.1

1. A metal bar of length 10 cm. is sliding over two metal rods at a constant velocity of 2 m/sec. There is good electrical contact between the bar and the rods, and the rods are connected at one end with a resistor of 1000 Ohms. There is a strong magnetic field of 2 Tesla pointing straight down (directly into the page in the figure; we are looking from above). What is the voltage induced across the resistor at the bottom? How much current flows through the resistor? Assume all the other conductors have negligible resistance.



2. Consider the situation in problem 1) again.

a) What would happen if the situation was as in 1, except the direction of motion of the bar was in the opposite direction?
b) What would happen if the situation was as in 1, except the direction of magnetic field was now up?

Session XI.2

3. A loop of area A is rotating perpendicular to a magnetic field B at a constant angular frequency ω—that is, the angle between B and the loop is increasing at a constant rate of ω.
a. Show that the magnetic flux could be represented by $BA\cos(\omega t)$.
b. Calculate the induced voltage over the loop.
c. How does your answer to b change if the loop is instead a coil of 100 turns of wire with the same area?

4. A transformer uses iron to make sure that all the magnetic flux passing through the primary ("sending") coil also goes through the secondary ("receiving") coil. Use Faradays Law to show that the ratio of the voltages on the primary and the secondary, assuming the resistance of the coils is negligible (in other words, the only voltage across a coil is the induced voltage given by Faraday), is simply the ratio of the number of turns of wire in the primary and secondary. (Hint—it is probably easiest to work backwards: start with the notion of the flux to calculate the voltage on each coil.) If a 12 V

transformer for your portable CD player has 100 turns of wire on the 120 V coil, how many turns are on the secondary (12 V side)?

5. I have a copper ring that I move from a region with no magnetic field into a strong magnetic field. The field is directed into the page, as shown. What direction is the induced current in the ring?