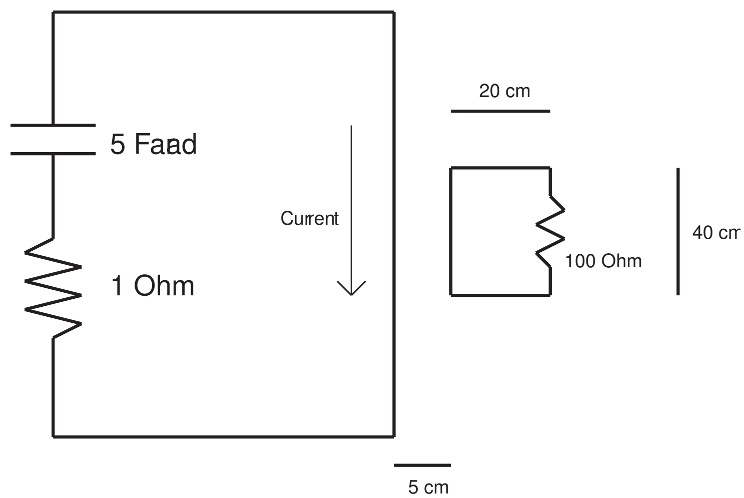
Name: ________________________

Changing Fields Homework

1. Consider a very large rectangular circuit with a 5 Farad capacitor charged to 50 Volts and a 1 Ohm resistor. A smaller conducting rectangle is set up 5 cm away from one side of the larger circuit. The smaller rectangle has a length of 40 cm and a width of 20 cm as shown, and has a resistance of 100 Ohms. You may treat the nearby side of the of the larger circuit as an infinitely long straight wire and ignore all the other wires for the purposes of calculating the magnetic field.



a. State the direction of the magnetic field produced by the current carrying wire through the smaller rectangle.

b. What will happen to the magnetic flux through the smaller rectangle as the capacitor discharges, will it increase or decrease?

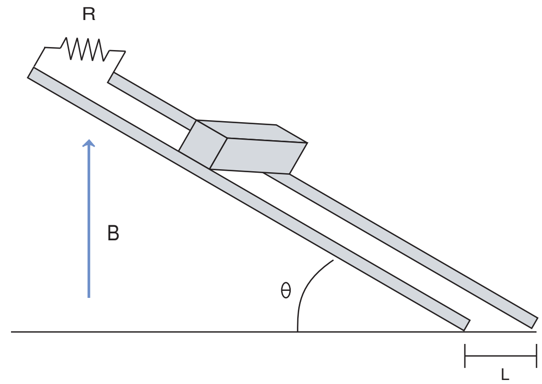
c. In what direction will the induced current flow in the small rectangle? Clockwise or counterclockwise?

d. Find the magnetic flux through the small rectangle in terms of the current through the long wire connected to the capacitor. Hint: the field only varies with the distance from the wire, so divide the loop into thin strips of area and integrate to find the total flux.

e. Write the current through the long wire as a function of time, and use this to write the magnetic flux through the small rectangle as a function of time.

f. Write the induced EMF and then current flowing through the small rectangle as a function of time. Graph this function.

2. A rectangular conducting rod of mass m is placed on top of two conducting rails inclined at an angle of θ from the horizontal. A uniform, constant magnetic field B is directed upwards. The rails are connected by a wire with resistance R creating a closed circuit. The force of gravity will cause the rod to slide down the rails with an increasing velocity v.



a. Show that there is a retarding force directed up the incline given by $F = \dfrac{B^2 L^2 v \cos^2\theta}{R}$.

b. Show that the terminal speed of the rod is $v = \dfrac{mgR\sin\theta}{B^2 L^2 \cos^2\theta}$