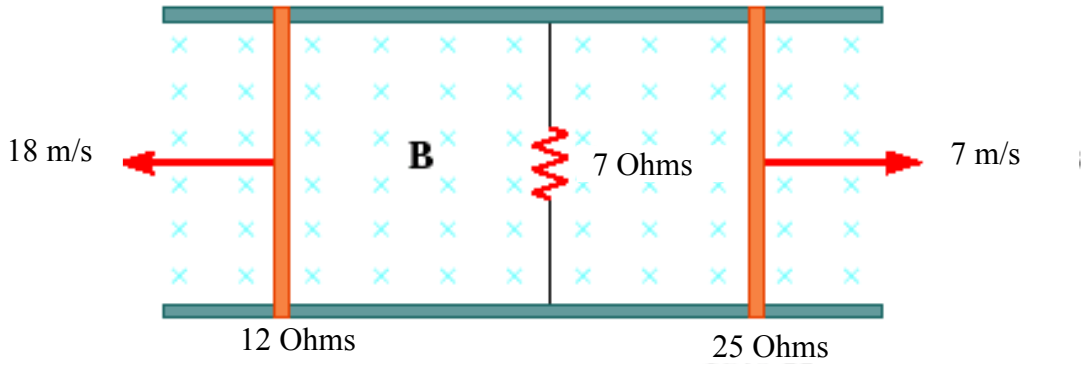
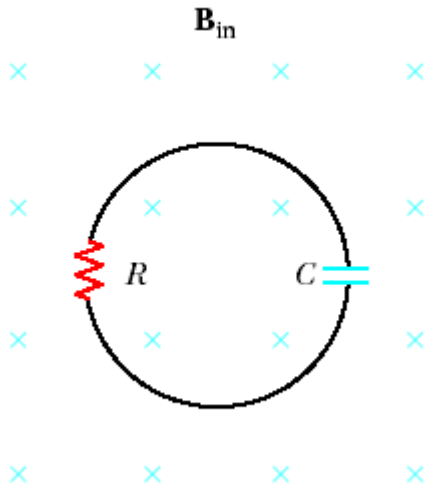
Physics 2201 E&M
Homework #16 – Due Mar. 8, 2016 by 3pm
(hand in to drop box outside 3L24)

1. A magnetic field of 1.4 T is to be set up in an iron-core toroid. The toroid has a mean radius of 8 cm, and magnetic permeability of $4000\mu_0$. What current is required if the winding has 370 turns of wire? The thickness of the iron ring is small compared to 8 cm, so the field in the material is nearly uniform.

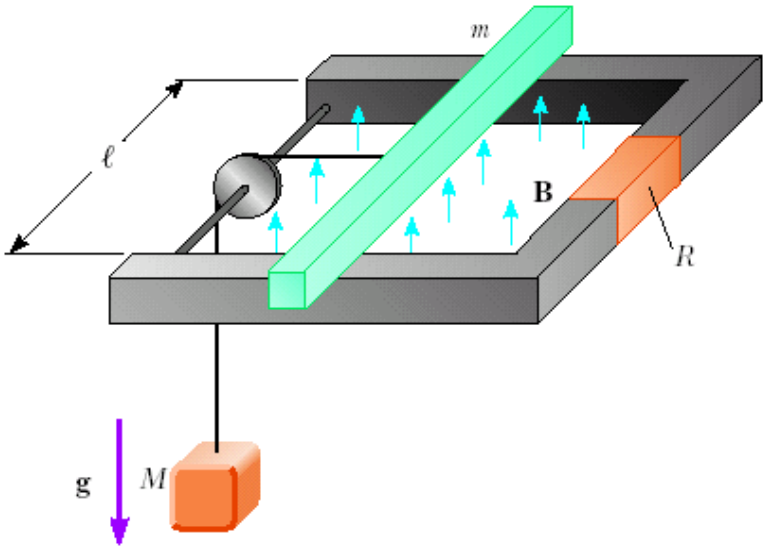
2. Two parallel rails with negligible resistance are 8 cm apart and are connected by a 7 Ohm resistor. The circuit also contains two metal rods having resistances of 12 Ohms and 25 Ohms sliding on the rails as shown in the figure below. The rods are pulled away from the resistor at constant speeds of 7 m/s and 18 m/s respectively. A uniform magnetic field of magnitude 0.04 T is applied perpendicular to the plane of the rails. Determine the current in the 7 Ohm resistor.



3. In the figure below, a uniform magnetic field decreases at a constant rate $dB/dt = -K$, where K is a positive constant. A circular loop of wire of radius a containing a resistance R and a capacitance C is placed with its plane normal to the field. (a) Find the charge Q on the capacitor when it is fully charged. (b) Which plate is at the higher potential? (c) Discuss the force that causes the separation of charges.



4. The bar of mass m in the figure is pulled horizontally across parallel rails by a massless string that passes over an ideal pulley and is attached to a suspended object of mass M. The uniform magnetic field has a magnitude B, and the distance between the rails is l. The rails are connected at one end by a load resistor R. Derive an expression that gives the horizontal speed of the bar as a function of time, assuming that the suspended object is released with the bar at rest at $t=0$. Assume no friction between rails and bar.



5. A small circular washer of radius r is held directly below a long straight wire carrying a current of I. The washer is located a height, h, above the top of a table, as shown in the figure below. (a) If the washer is dropped from rest, what is the magnitude of the average induced emf in the washer from the time it is released to the moment it hits the tabletop? Assume that the magnetic field is nearly constant over the area of the washer, and equal to the magnetic field at the centre of the washer. (b) What is the direction of the induced current in the washer?