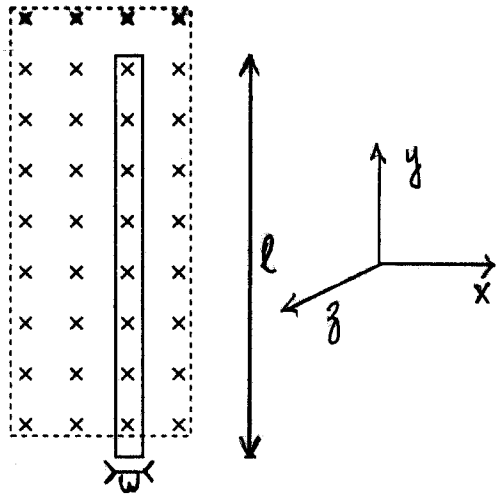
PHY6938 E & M Fall 2000

1. The accompanying figure shows a rectangular loop of wire, $w = 0.30$ m wide and $l = 1.50$ m long, in the vertical plane and perpendicular to a uniform magnetic field $B = 0.40$ T, directed into the page as shown. The magnetic field is limited to the region indicated by the dashed rectangle. The portion of the loop not in the magnetic field is 0.10 m long. The resistance of the loop is 0.20 Ω and its mass is 0.50 kg. The loop is released from rest at $t = 0$.



a) What is the magnitude and direction of the induced current when the loop has a downward velocity v?

b) What is the net force acting on the loop?

c) Write the equation of motion of the loop and obtain an expression for the velocity and displacement of the loop as a function of time. Your answers should include only t as an unknown. All constants should be evaluated. Consider only times short enough that part of the loop is still inside the magnetic field.

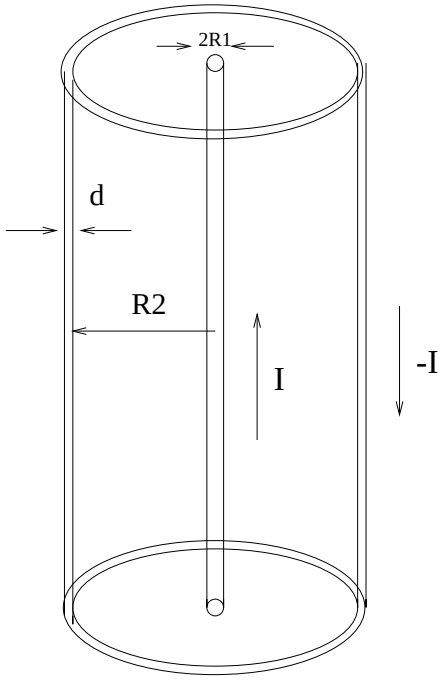
2. A point charge of +5 C is on the x-axis at $x = -3$ m and a second point charge of -2 C is on the x-axis at $x = +4$ m.

a) Find all the points on the x-axis where the electric potential is zero.

b) Draw a graph of the electric potential $V(x)$ vs x for -10 m $< x < +10$ m.

c) How much work is needed to bring a third charge of +3 C from infinity to the point $x = +1$ m on the x-axis?

3. Consider a coaxial cable made of a hollow cylindrical wire of inner radius R_2 and thickness d and a wire in the center of radius R_1 as shown in figure. The wire axis is labeled the z-axis. A total current I flows in the inner wire along the positive z direction and a total current I flows in the outer hollow cylindrical wire in the negative z direction. The current densities in both conductors are constant throughout their volumes.



a) Find the magnetic field inside the inner wire, i.e. for $r < R_1$.

b) Find the magnetic field in the space between the wires, i.e. for $R_1 < r < R_2$.

c) Find the magnetic field inside the outer wire, i.e. for $R_2 < r < R_2 + d$.

d) Find the magnetic field in the space for $r > R_2 + d$.