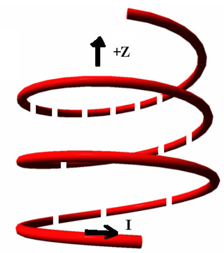
Monday March 22, 2010	**Physics 220:Untest #3:Page 1**	**Name: ______________________**

Instructions: You have a total of 50 minutes to complete this test.
Answer each of the following questions completely, showing full details with correct SI units.
Time Start________________ Time finish______________ Pledged__________________________
Do not discuss any aspect of this test with anyone until I return the test.
Constants: $\mu_0 = 4\pi\times10^{-7}\,\frac{\text{Tm}}{\text{A}}$



[1] An ideal solenoid has a total length h and the interior cross sectional area is A with windings as shown to the right. A current I is injected into the solenoid at the top and it exits at the bottom as shown. Note that in the image to the right, dashed portions are behind while solid portions are in front.

In answering the following questions, you must show complete details leading up to your answer for full credit.

(a) Calculate the **vector magnetic** field inside the solenoid near the center**. You must show details, use words and sketches. Your answer involves n, I and a constant.**

(b) Suppose the solenoid has a total of N turns. Assuming the magnetic field is uniform throughout the solenoid, calculate the total magnetic flux in the solenoid when this current is flowing. Your answer involves n, I and the interior volume of the solenoid.

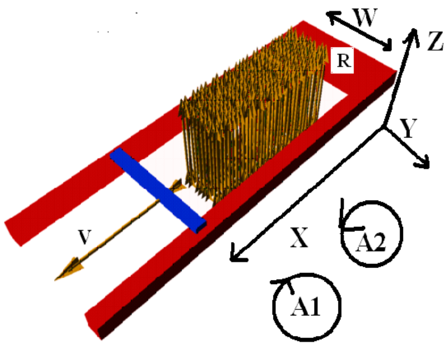
(c) Calculate the inductance of the solenoid.

(d) Calculate the total magnetostatic energy of the solenoid. Here, express your answer in terms of a constant, B, A and h.

(e) Provide numerical answers for (a), (b), (c) and (d) together with correct SI units for the case I=1A, n=1000/m, A=0.1 m^2, h=1 m.

(e:a)_________________________ (e:b)_________________________

(e:c)_________________________ (e:d)_________________________



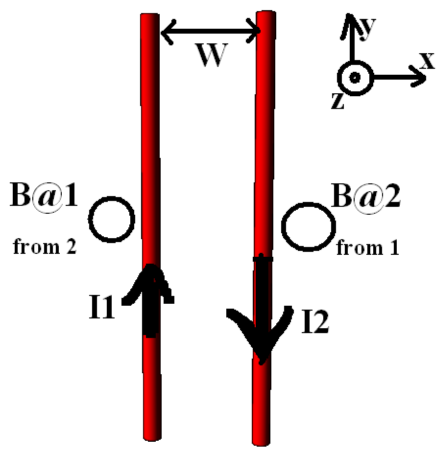
[2] Consider the following situation: conducting rail is moving with an instantaneous position given by $x = pt$ (p is a constant). In the area enclosed by the rail system, a uniform magnetic field (B) is directed into the +z direction. The rail system has a total resistance (at the end only) given by R and this value is assumed to be constant throughout this problem.

(a) At an instant in time, calculate the magnetic flux through the enclosed region of the system. You may assume the normal to the area of the enclosed region points into the +z direction.

(b) Find the magnitude of the induced emf in the system at any time t.

(c) Which direction will the induced current flow: (A1 or A2) and why (in words). Be very clear in your answer to this question.

(4) Suppose R=10 Ω, p=3 m/s, w=0.1 m and B=1 T. Provide numerical answers to (a), (b) and (c) together with correct SI units.



[3] Two long wires (each with the same length h) carry currents I1 and I2 in the directions shown. In the coordinate system indicated, z is out of the paper. You may assume the wires are long enough so that they may be treated as ideal.

(a) In the circles provided, show the direction that the magnetic fields point for B at 1 from 2 and B at 2 from 1.

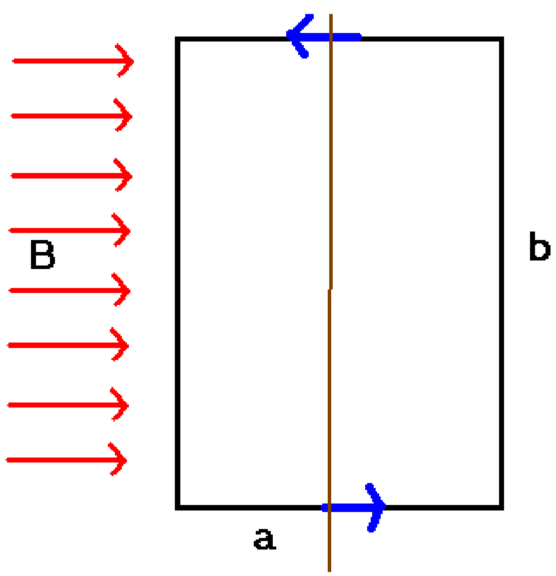
(b) Showing **complete details**, calculate the magnitude of the magnetic field B@2 from 1.

(c) Calculate the **Vector Force** on wire 2 due to wire 1. You must include correct unit vectors here for credit.

(d) Suppose that I1=1.5A, I2=2.5A, w=0.1 m and h=1.5 m. Provide numerical answer for (b) and (c) together with correct SI units.

(d:b)____________________________ (d:c)________________________

[4] Suppose a wire has a radius a, and current I is uniformly distributed over the area of the wire so that $J=I/(\pi a^2)$. Find the direction and magnitude of the magnetic field both inside the wire.



[5] Consider the current loop shown with one side of length b and the other side of length a. A current I flows in the circuit. Find the magnitude of the torque on the current loop in the presence of an externally applied magnetic field $\vec{B} = B\hat{x}$ about the axis shown which the circuit is permitted to rotate about. The magnetic field is in the $+\hat{x}$ direction and the axis about which the loop rotates is along the $\hat{y}$ direction. Initially the current loop is in the x-y plane.