| Wednesday, March 30, 2016 | **Physics250: Test 03** | Name _____ |
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**Instructions: You have a total of 50 minutes to complete this test.**
**Answer each question completely showing complete details.**
**For complete credit you must include correct SI units with numerical answers.**

Time Start_____ Time finish _____pledged _____

Constants: $\mu_0 = 4\pi x 10^{-7} \frac{Tm}{A}$

**[1]** A circuit consists of an inductor (L=5x10$^{-5}$ h) and a capacitor (C=5x10$^{-5}$ f).
**[a]** Calculate the resonance frequency (f) of this circuit.

f=_____

**[b]** Another circuit consists of an inductor (L=5x10$^{-5}$ h) , a capacitor (C=5x10$^{-5}$ f) and a resistor (R=159 Ω) in series. If the circuit is operated at f=100 Hz, calculate the impedance of this circuit.

**Z=_____**

**[c]** A transformer consists of a primary coil with 100 turns and a secondary coil with 50 turns. If an input voltage of 10 V (RMS) AC is applied to the primary side, what is the secondary voltage?

**[d]** A transformer consists of a primary coil with 100 turns and a secondary coil with 50 turns. If an input voltage of 10 V (RMS) DC is applied to the primary side, what is the secondary voltage?

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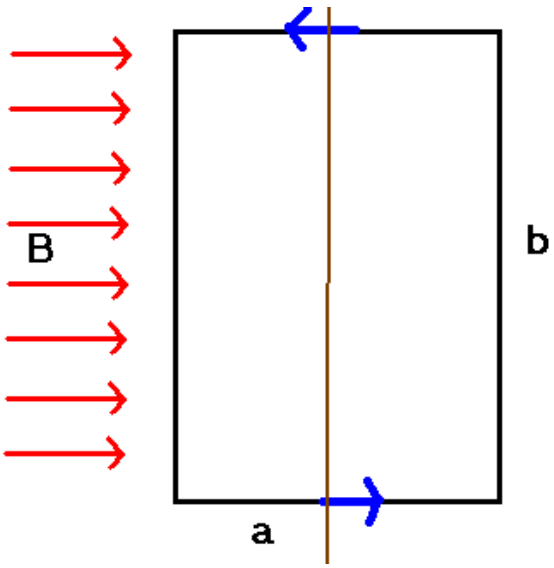


**[2]** (a) Consider the current loop shown with one side of length b and the other side of length a. A current I flows in the circuit. Find the magnitude of the torque on the current loop in the presence of an externally applied magnetic field $\vec{B}=B\hat{x}$ about the axis shown which the circuit 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.

**[2] (b)** 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.

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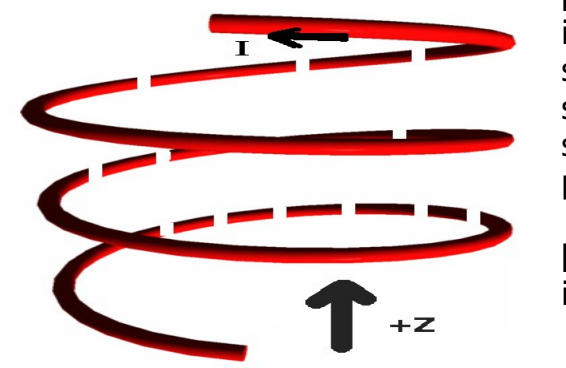


**[3]** An ideal solenoid has a total length h and the interior cross sectional area is A with windings as shown to the right. A current I is injected into the solenoid at the bottom and exits at the top as shown. Note that in the image to the right, dashed portions are behind while solid portions are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

**[a]** Circle the correct direction for the magnetic field inside the solenoid.

$+\hat{z}$ $-\hat{z}$

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

**[b]** Calculate the magnitude of the magnetic field inside the solenoid near the center**. You must show details, use words, include assumptions and sketches. Your answer must involve n, I and a constant.**

**[c]** Suppose the solenoid has a total of N turns. Assuming the magnetic field is uniform throughout the solenoid, calculate the inductance of the solenoid. Your answer involves n, and the interior volume of the solenoid.

**[d]** Calculate the magnetostatic energy density of the solenoid. Here, express your answer in terms of a constant and B.

**[e]** Provide numerical answers for (b), (c), and (d) **together with correct SI units** for the case I=10A, n=200/m, A=0.5 $m^2$, h=0.1 m.

**[e:b] _____ [e:c] _____ [e:d] _____**

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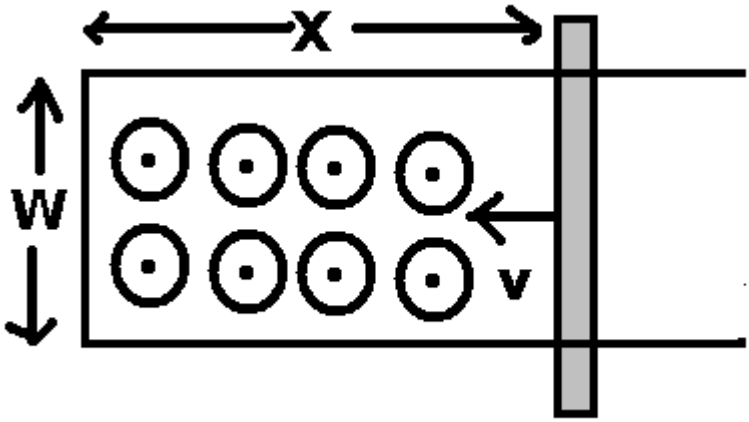
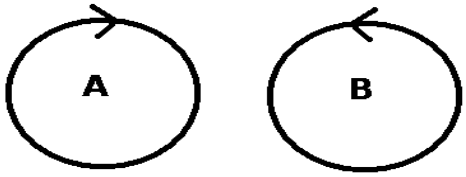
**[4]** Consider the following situation: a conducting rail is moving with an instantaneous position given by $x=x_0+v_0t+ct^3$ ($x_0$ , $v_0$ and c are constants with units m, m/s and $m/s^3$ respectively and the rail is moving in the -x direction). In the area enclosed by the rail system, a uniform magnetic field (B) is directed into the positive z direction: $\vec{B}=|\vec{B}|\hat{z}$ . 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 in terms. 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: (A or B) and why (in words). Be very clear in your answer to this question.

**[d]** Suppose $v_0$ =-1 m/s, c=0.1 $m/s^3$ w=0.5 m, $x_0$=100m, t=2s, and B=1 T. Provide numerical answers to [a] and [b] **together with correct SI units.**

**[d:a]** _____ **[d:b]** _____