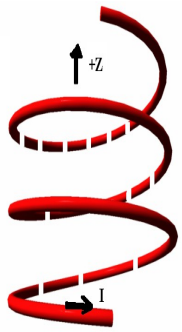
Monday, March 30, 2015	**Physics250: UnTest 03**	Name _____

Instructions: You have a total of 55 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: $\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$

[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 exits at the bottom 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=2000/m, A=0.1 m^2, h=1 m.

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

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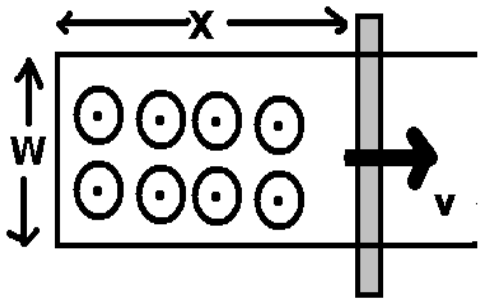
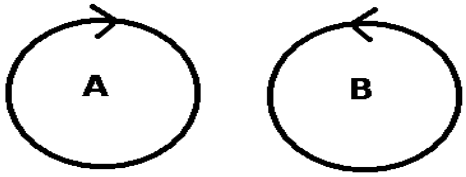
[2] Consider the following situation: a conducting rail is moving with an instantaneous position given by $x = x_0 + v_0 t + pt^4$ (x_0 , v_0 and p are constants and the rail is moving in the +x direction). In the area enclosed by the rail system, a uniform magnetic field (B) is directed into the positive 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. 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=5 m/s, p=10 m/s^4, w=0.5 m, x_0=100m, t=1s, and B=1 T. Provide numerical answers to [a] and [b] **together with correct SI units.**

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

[3] A transformer consists of two coils with N_p=10 turns on the primary side and N_s=20 turns on the secondary side. You may assume perfect flux coupling here. **Be sure to use correct SI units in your answers.**
[a] If a AC voltage of 10 V (RMS) is input on the primary side of the transformer, what is the (RMS) output voltage?

[b] If a DC voltage of 100 V is input on the primary side of the transformer, what is the output voltage?

[c] A circuit consists of an inductor (L=10μh), a capacitor (C=0.1μf) and a resistor (R=100 Ω) all in a **series configuration**. Calculate the resonance frequency (f_0) of this circuit for the case R=0.

[d] Calculate the impedance (Z) of the circuit described in part [c] when operated at a frequency of f=1000Hz. Be sure to provide correct SI units here.

Z=_____

(4) When an object is placed at a distance of 40 cm from a lens, the magnification is -2.
(a) What is the focal length of the lens?

(b) If the object is placed at 10 cm from the same lens, what is the magnification of the image?

(c) Characterize the image formed in (b) by <Real:Virtual> <Upright:Inverted> <Enlarged:Unmagnified:Reduced> and tell why.