PHYSICS 211
Final
TIME: 120 minutes

August 12, 2008

DO NOT OPEN THIS EXAM BEFORE YOU ARE TOLD TO BEGIN

NAME_____

ID Number _____

Useful information
$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$.
$\mu_0 = 4p \times 10^{-7}\ Tm/A$.
$q = 1.6 \times 10^{-19}\ C$
$m_e = 9.1 \times 10^{-31}$ kg. $m_p = 1.67 \times 10^{-27}$ kg.
$k_e = 8.9875 \times 10^9\ Nm^2/C^2$

Grading

A	
B	
TOTAL	

Score:_____

☐ Check if solution is continued on the back.

Part A: Multiple choice questions (36) each question has 3

1. What is the magnetic force on a 2.0-m length of (straight) wire carrying a current of 30 A in a region where a uniform magnetic field has a magnitude of 55 mT and is directed at an angle of 20° away from the wire?

a. 1.5 N
b. 1.3 N
c. 1.1 N
d. 1.7 N
e. 3.1 N

2. A proton is accelerated from rest through a potential difference of 2.5 kV and then moves perpendicularly through a uniform 0.60-T magnetic field. What is the radius of the resulting path?

a. 15 mm
b. 12 mm
c. 18 mm
d. 24 mm
e. 8.5 mm

3. A planar loop consisting of four turns of wire, each of which encloses 200 cm^2, is oriented perpendicularly to a magnetic field that increases uniformly in magnitude from 10 mT to 25 mT in a time of 5.0 ms. What is the resulting induced current in the coil if the resistance of the coil is 5.0 Ω?

a. 60 mA
b. 12 mA
c. 0.24 mA
d. 48 mA

4. A bar magnet is falling through a loop of wire with constant velocity. The south pole enters first. As the magnet leaves the wire, the induced current (as viewed from above):

a. is clockwise.
b. is counterclockwise.
c. is zero.
d. is along the length of the magnet.

5. An inductor produces a back emf in a DC series RL circuit when a switch connecting the battery to the circuit is closed. We can explain this by

a. Lenz's law.
b. increasing magnetic flux within the coils of the inductor.
c. increasing current in the coils of the inductor.
d. all of the above.
e. only (a) and (c) above.

Score:_____

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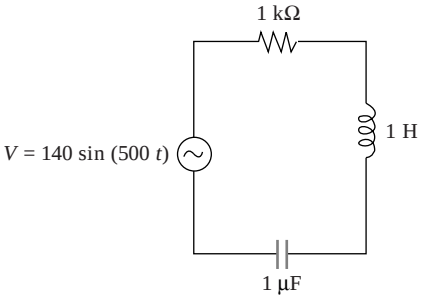
6. A series *LC* circuit contains a 100 mH inductor, a 36.0 mF capacitor and a 12 V battery. The frequency of the electromagnetic oscillations in the circuit is

a. 5.73×10^{-4} Hz.
b. 9.55×10^{-3} Hz.
c. 0.442 Hz.
d. 2.66 Hz.
e. 44.0 Hz.

7. The total impedance *Z* of an *RLC* circuit driven by an ac voltage source at angular frequency ω is,

a. $\sqrt{R^2 + (\omega L)^2 - X_{C^2}}$
b. $\sqrt{R^2 + (X_L - X_C)^2}$
c. $\dfrac{1}{\sqrt{R^2 + (X_L - X_C)^2}}$
d. $\sqrt{R^2 + (X_L + X_C)^2}$
e. $\sqrt{R^2 - (X_L + X_C)^2}$

8. Determine the resonant frequency of the circuit.



a. 159 Hz
b. 32 Hz
c. 5 Hz
d. 500 Hz
e. 79.5 Hz

9. How much electromagnetic energy is contained in each cubic meter near the Earth's surface if the intensity of sunlight under clear skies is 1000 W/m^2?

a. 3.3×10^{-6} J
b. 3.3 J
c. 0.003 J
d. 10^{-4} J
e. 3.0×10^{5} J

Score:_____

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10. Magnetic fields are produced by

a. constant electric currents.
b. electric currents that vary sinusoidally with time.
c. time-varying electric fields.
d. all of the above.
e. only (a) and (b) above.

11. The magnetic field amplitude in an electromagnetic wave in vacuum is related to the electric field amplitude by $B =$

a. $\frac{E}{c}$.
b. $\frac{E}{\sqrt{c}}$.
c. E.
d. $E\sqrt{c}$.
e. cE.

12. A copper wire of length 25 cm is in a magnetic field of 0.20 T. If it has a mass of 10 g, what is the minimum current through the wire that would cause a magnetic force equal to its weight?

a. 1.3 A
b. 1.5 A
c. 2.0 A
d. 4.9 A

Score:_____

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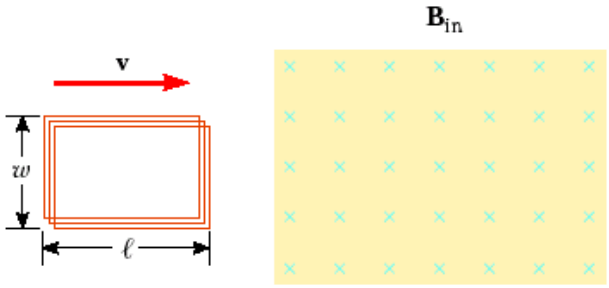
Part B- Problems (64 %)

1. (14) A rectangular coil with resistance R has N turns, each of length ℓ and width w as shown in the Figure below. The coil moves into a uniform magnetic field **B** with constant velocity **v**.



(a)(5) What are the magnitude and direction of the total magnetic force on the coil as it enters the magnetic field.

(b)(5) What are the magnitude and direction of the total magnetic force on the coil as it moves within the field.

(c)(4) What are the magnitude and direction of the total magnetic force on the coil as it leaves the field?

Score:_____

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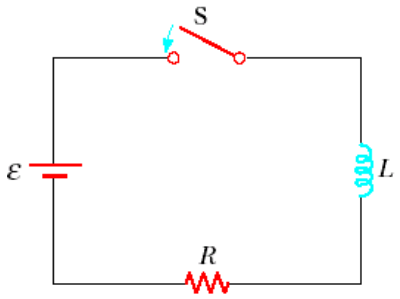
2.(15) Consider the circuit in the Figure below, taking $\mathcal{E}$ = 6.00 V, L = 8.00 mH, and R = 4.00 **Ω**.



(a)(7) Using Kirchhoff, calculate the analytical expression of the current in the circuit and deduce the analytical and the numerical values of the inductive time constant?

(b)(4) Calculate the current in the circuit 250 μs after the switch is closed.

(c)(4) What is the value of the final steady-state current?

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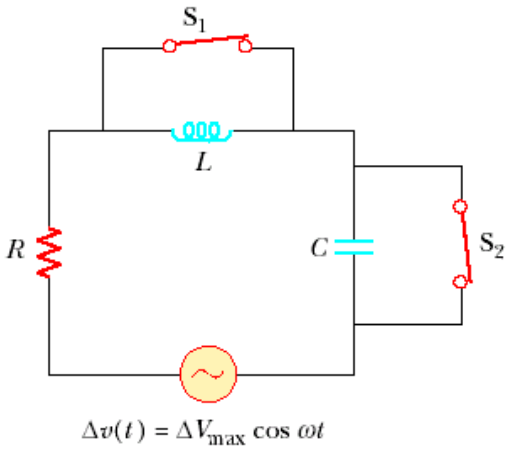
3.(35%) In the circuit shown in the Figure below, assume that all parameters except for *C* are given and the two switches are closed.



(a)(5) Find the analytical expression of the current as a function of time.

(b)(5) Find the power delivered to the circuit.

(c)(5) Find the current as a function of time after *only* switch 1 is opened.

(d)(5) After switch 2 is *also* opened, the current and voltage are in phase. Find the capacitance *C*.

Score:_____

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(e)(5) Find the impedance of the circuit when both switches are open.

(f)(5) Find the maximum energy stored in the capacitor and in the inductor during oscillations.

(g)(5) Find the frequency that makes the inductive reactance half the capacitive reactance.

Score:_____

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SCRATCH PAPER

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