General Physics II **Exam 3 - Chs. 18B,21,22 - Electromagnetism** **Mar. 23, 2009**

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show the formulas you use, all the essential steps, and results with correct units and correct number of significant figures. Point values are given in parenthesis. For TF or MC questions, choose the best answer. Coulomb's Law constant $k = 8.988$ GN·m^2/C^2, permittivity of free space $\epsilon_0 = 8.854$ pF/m, permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ T·m/A, elementary charge $e = 1.602 \times 10^{-19}$ C, electron mass $m_e = 9.11 \times 10^{-31}$ kg, 1 electron-volt = 1.0 eV = 1.602×10^{-19} J, 1 gauss = 1 G = 1.0×10^{-4} T.

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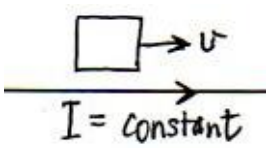
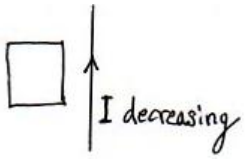
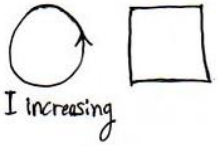
1. (6) For the situations shown, put an arrow on the square wire loop in each diagram to show the direction of the induced current. If there is no induced current, write $I = 0$ within the loop.

a) 

b) 

c) 

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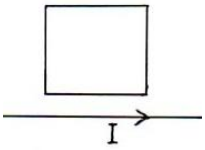
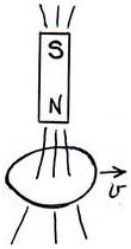
2. (2) In this situation, the square loop of wire has a clockwise induced current caused by the other nearby wire. The current in that other wire is



a. zero. b. constant.
c. increasing. d. decreasing.

3. (2) If the circular wire loop is suddenly pulled to the right from this initial position near a bar magnet, the induced current in the loop is



a. zero b. clockwise.
c. counterclockwise.

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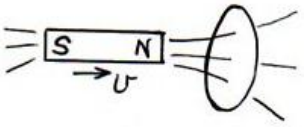
4. (4) The bar magnet is being pushed towards the circular loop of wire.



a) (2) Viewed from the left side, the induced current in the loop is

a. zero. b. clockwise. c. counterclockwise.

b) (2) The resulting magnetic force on the loop is closest to

a. zero. b. to the left. c. to the right. d. up. e. down.

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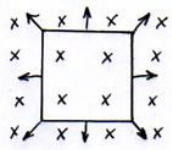
5. (2) A square wire loop placed in a magnetic field, is made of a stretchable conductor (like a rubber band), so that its size can increase as shown. The emf (or current) induced in the loop is



a. zero. b. clockwise. c. counterclockwise.

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6. (2) If a short bar magnet is dropped down the center of a copper pipe, the magnetic force on the bar magnet is

a. ← b. → c. ↑ d. ↓

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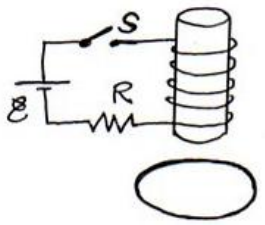
7. (8) A 75-watt lightbulb is being powered by usual 120 volt-rms household AC.

a) (4) Find the rms current through the lightbulb.

b) (4) What are the minimum and maximum *instantaneous* powers used by the lightbulb?

8. (6) A wire loop is at a fixed position below a solenoid, whose magnetic field lines can pass through the loop. Suppose you are above the loop looking down.



a) (2) When the switch is closed, the magnetic field inside the wire loop, due to the solenoid, points approximately

a. up through the loop. b. down through the loop.
c. horizontally in the plane of the loop.

b) (2) Just after the switch is closed, the current induced in the loop is

a. zero. b. clockwise. c. counterclockwise.

c) (2) After the switch has been closed a very long time, the current induced in the loop is

a. zero. b. clockwise. c. counterclockwise.

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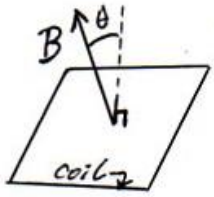
9. (10) A square coil is 20.0 cm × 20.0 cm and has 200. turns of wire. There is a magnetic field that can pass through the coil at an angle θ to the normal of the plane of the coil.



a) (5) If $\theta = 60.0°$ is fixed, but B changes from 0 to 5.00 kG in 0.100 seconds, what magnitude emf is induced in the coil?

b) (5) If $B = 5.00$ kG is fixed, but θ changes from 90.0° to 0° in 0.100 seconds, what magnitude emf is induced in the coil?

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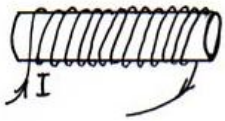
10. (10) To make an inductor, you take 1000. meters of thin copper wire and wrap it uniformly around a 25.0 cm long hollow cylinder with a 1.00 cm radius.



a) (4) How many turns of wire will you get for your inductor?

b) (4) What will be the resulting self-inductance of this solenoid?

c) (2) If an increasing current is sent into the inductor as shown, which wire end is at higher voltage, due to the self-emf? Select: **left end** or **right end**

Name Rec. Instr. Rec. Time

11. (8) A generator is set up by taking a rectangular 15.0 cm × 20.0 cm coil with 440. turns of wire, and spinning it at 3.60×10^3 rpm in a uniform 0.250 tesla magnetic field produced by permanent magnets.

a) (4) What is the frequency of AC voltage being generated, in hertz?

b) (4) What is the peak voltage for the AC voltage being generated, in volts?

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12. (2) Which type of electromagnetic waves has the shortest wavelength when travelling through vacuum?

a. radio waves b. microwaves c. yellow light d. all have the same wavelength.

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13. (2) Which is true about the electric and magnetic fields in an electromagnetic wave?

a. $\vec{B}$ is parallel to $\vec{E}$ and synchronized with $\vec{E}$.
b. $\vec{B}$ is perpendicular to $\vec{E}$ and synchronized with $\vec{E}$.
c. $\vec{B}$ is parallel to $\vec{E}$ but out of phase with $\vec{E}$.
d. $\vec{B}$ is perpendicular to $\vec{E}$ but out of phase with $\vec{E}$.

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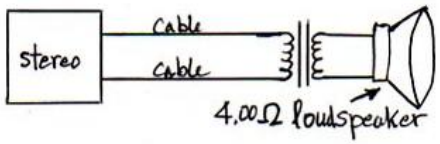
14. (14) AC power at 88.0 V (rms) is sent along cables (each with 0.100 Ω resistance) from a stereo to a transformer whose secondary coil drives a loudspeaker. The 4.00 Ω loudspeaker uses 75.0 W (average) of electric power. The transformer is ideal.



a) (6) Find the turns ratio of the transformer, i.e., N_p/N_s. Is it a **step-up** or **step-down** transformer?

b) (4) What is the rms current in the cables from the stereo to the transformer?

c) (4) How much power is being wasted as heat in the cables?

15. (10) A cell phone is emitting electromagnetic waves isotropically with a total power of 0.50 W at 890 GHz. At a distance of 4.0 m from the phone,

a) (4) what is the intensity I of the EM waves?

b) (6) what are the amplitudes of the electric and magnetic fields in the waves, E_0 and B_0?

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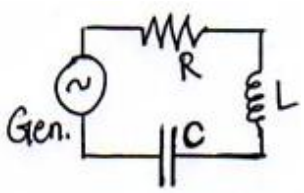
16. (16) A series RLC circuit is setup as shown. The generator operates at frequency $f = 5.60$ kHz, with rms voltage $V_{\text{gen}} = 90.0$ V. It is seen that the rms voltages across inductor and capacitor are $V_C = 64.0$ V and , $V_L = 144$ V.



a) (6) How large is the rms voltage across the resistor?

b) (2) The instantaneous voltage across the generator _____ the instantanenous current from the generator.

a. leads b. lags c. is in phase with

c) (2) At any instant, the voltages across the inductor and resistor are

a. in phase. b. 90° out of phase. c. 180° out of phase.

d) (6) What is the resonant frequency of the circuit? [Hint: You don't necessarily need to find L and C, but you *do* need to use their voltages.]