PHYSICS 265

Test #2

1 April 1997

Name: ______________________________ Section: ______

Part A. Choose the best answer from those given. (5 points each)

1. The force between 2 parallel, current carrying conductors does **not** depend

   - ☐ a) on the separation of the wires.
   - ☐ b) on the values of the current in the wires.
   - ☐ c) on whether the currents flow in the same or opposite directions.
   - ☐ d) on whether the wires are pointing N-S or E-W.
   - ☐ e) none of these.

2. Eli the Iceman

   - ☐ a) keeps the soda in the food court cold.
   - ☐ b) reminds us of the relative phases of v and i in L and C circuits.
   - ☐ c) was instrumental in discovering the connection between magnetic fields and currents in wires.
   - ☐ d) won a Nobel prize for discovering resonance in LC circuits.
   - ☐ e) none of these.

3. A step up transformer has a ratio one to ten (primary turns to secondary turns). If 100 W of power go into the primary coil, the power coming out of the secondary coil is

   - ☐ a) 1 W.
   - ☐ b) 10 W.
   - ☐ c) 100 W.
   - ☐ d) 1000 W.
   - ☐ e) none of these.

4. The *inductive time constant* τ_L in an LR circuit depends on

   - ☐ a) the value of R.
   - ☐ b) the applied potential difference.
   - ☐ c) the value of L.
   - ☐ d) the values of R and L.
   - ☐ e) the values of R and L and the applied potential difference.

Part B. Answer 4 of the following 5 questions. (20 points each)

1. An electron ($m = 9.11 \times 10^{-31}\ kg$) is moving with a velocity of $3.00 \times 10^{6}\ m/s$ perpendicular to a magnetic field $B = 1.00 \times 10^{-4}\ T$. The magnetic field points in the $+z$ direction (out of the page).

   a) If an electric field $\vec{E}$ (perpendicular to the magnetic field) is present, such that the electron moves with constant velocity in the $+x$ direction, what is the magnitude and direction of $\vec{E}$? (10 points)

   b) The electric field is removed, and the electron moves in a circle. What is the radius of the circle? (10 points)

2. A transformer, just outside your house, steps the potential of the electricity from about $110,000\ V$ to a usable $110\ V$ (these are both AC, rms voltages). The primary coil of the transformer has 10 turns. The wire carrying the electricity from the power generating station to your house has a resistance of $1\ \Omega$ per mile.

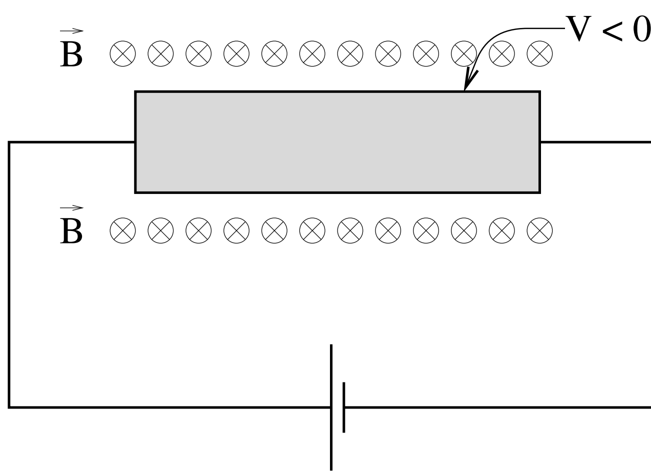
   a) How many turns does the secondary coil of the transformer have? (10 points)

   b) At one point in the day, your household is using $30\ A$ of current (at $110\ V$); you are using energy at a rate $P = IV = 3300\ W$. If the power station transmitted the electricity at $110\ V$ **instead** of using transformers, at what rate would energy be dissipated per mile of wire? (10 points)

   c) Using the results from part b), can you explain why electricity is transferred at very high voltage? (bonus)

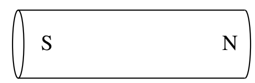
3. a) An airplane with 10 m wingspan is flying 360 kph relative to the ground. If there is a potential difference of 4 V between the wingtips, what is the magnitude of the magnetic field (assume it is perpendicular to the wings and to the direction of motion)? (10 points)

b) In the Hall effect apparatus shown, the potential of the upper edge of the ribbon is as indicated. If the $\vec{B}$ field is into the page as shown, what sign are the charges moving through the ribbon? Briefly, describe your reasoning. (10 points)

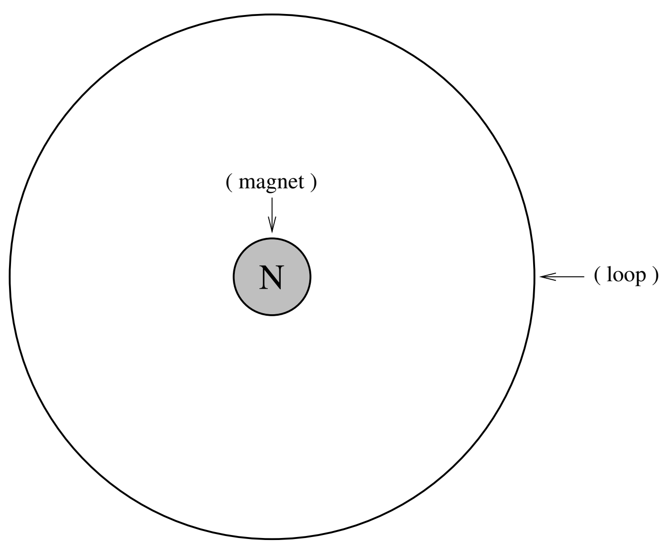


4. You have a single turn loop of wire and a cylindrical permanent magnet with N and S poles correctly labeled. The loop has a cross sectional area of 100 cm^2.

   a) Sketch roughly the shape of the magnetic field lines of the magnet. Draw arrows to indicate the direction of the $\vec{B}$ field lines. (4 points)



   b) In the view below, you are looking through the loop towards the N pole of the magnet (*i.e.,* the magnet is on the other side of the loop). The magnet is brought towards you and the loop, but it remains on the other side of the loop from you. Sketch the direction of the induced current flow. Briefly, describe your reasoning. (8 points)



   c) The magnet is moved towards the loop (as above), such that the magnetic due to the magnet increases from approximately 0 to 2.00 mT in 10.0 s. What is the average induced emf in the loop? (8 points)

5. You are studying a series LRC circuit. You discover that the resonance frequency of the circuit is 1000 Hz, and, at that frequency, a current of 10.0 A flows when the voltage applied is 100 V (these are both AC, rms values). You are also told that the inductor has an inductance of 1.00 mH.

a) What is the capacitance in the circuit? (8 points)

b) What is the resistance in the circuit? (8 points)

c) What are the impedance Z and phase angle ϕ if the circuit is at a frequency of 60 Hz? (4 points)