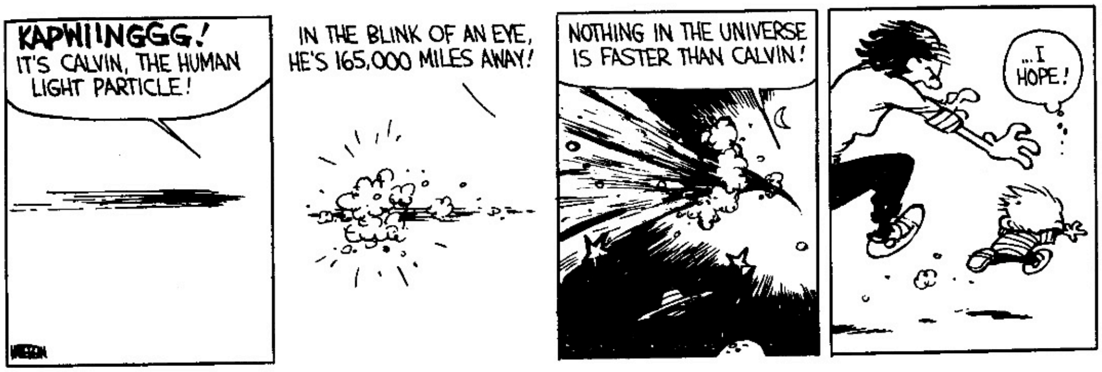
Physics 4L, Spring 2010 — Problem set 11
Due Tuesday April 20 in class



Turn in the attached two-page worksheet and the following problems:

Chapter 27: question 2 and problem 37; for 37 also show that the total energy dissipated as heat in the resistor equals the work done pulling the loop
Chapter 29: question 11 and problem 72

Additional problems:

1. The current in a 20-cm-diameter solenoid is increasing at the rate of 1.0 A/s. The solenoid has 1000 turns and is 1 m long. A 30-cm-diameter coil is wrapped around the outside and the induced emf in this coil is 15 mV. How many turns are in the coil?

2. The figure to the right is taken from *Organic Chemistry*, Maitland Jones, Jr. and shows why the net magnetic field experienced by a proton in a molecule is not exactly the same as the applied magnetic field B_0. Imagine looking at this system from above, so that the applied field appears to be coming directly toward you ("out of the page" if drawn on a sheet of paper). Sketch the proton, the applied magnetic field, and the electron cloud as seen from above, and show the direction of the induced current (i.e. the direction in which the electrons circulate in response to the applied magnetic field.)

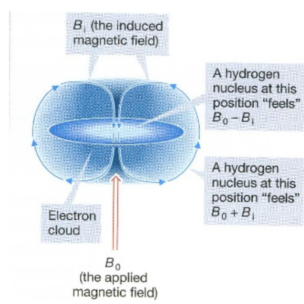


FIGURE 15.22 In an applied magnetic field (B_0), electrons will circulate so as to generate an induced magnetic field (B_i) that will oppose the applied field.

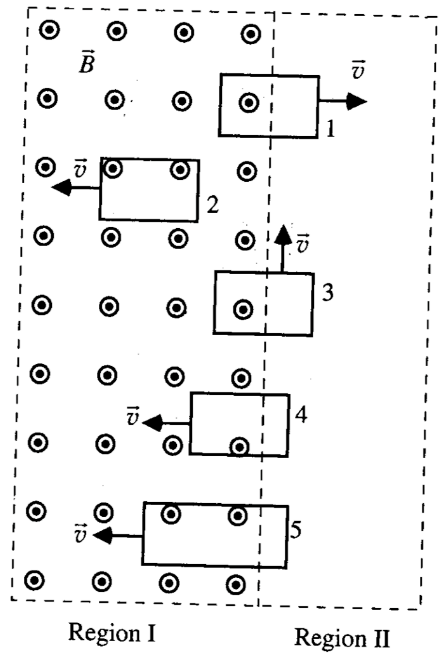
3. The relationship between wave speed, wavelength, and frequency for electromagnetic waves is $c = \lambda f$. Two electromagnetic waves have wavelengths λ_1 and λ_2; $\lambda_1 = 1.25\lambda_2$. Does this require that the two waves travel at different speeds? Explain briefly.

4. A laser pointer delivers 0.10 mW average power in a beam 0.90 mm in diameter. At a point 1 cm in front of the laser pointer, find (a) the average intensity, (b) the peak electric field strength, and (c) the peak magnetic field strength.

Finally, you should be able to do the following exercises but do not have to hand them in (solutions will be provided as part of the problem set solutions): Chapter 29 problems 15, 16, and 22

2. Five loops are formed of copper wire of the same gauge (cross-sectional area). Loops 1–4 are identical; loop 5 has the same height as the others but is longer. At the instant shown, all the loops are moving at the same speed in the directions indicated.

There is a uniform magnetic field pointing out of the page in region I; in region II there is no magnetic field. Ignore any interactions between the loops.



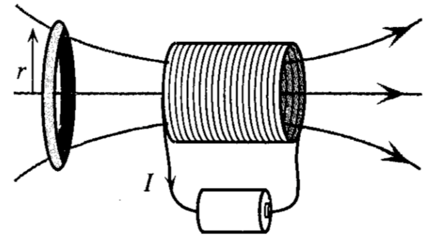
a. For any loop that has an induced current, indicate the direction of that current.

b. Rank the magnitudes of the *emfs* around the loops. Explain your reasoning.

c. Rank the magnitudes of the currents in the loops. Explain your reasoning.

2. A copper wire loop is constructed so that its radius, r, can change. It is held near a solenoid that has a constant current through it.

   a. Suppose that the radius of the loop were increasing. Use Lenz' law to explain why there would be an induced current through the wire. Indicate the direction of that current.



   b. Check your answer regarding the direction of the induced current by considering the magnetic force that is exerted on the charge in the wire of the loop.

   c. Find:

   - the direction of the magnetic moment of the loop and

   - the direction of the force exerted on the loop by the solenoid.

3 A copper wire loop is initially at rest in a uniform magnetic field. Between times $t = t_o$ and $t = t_o + \Delta t$ the loop is rotated about a vertical axis as shown.

Will current flow through the wire of the loop during this time interval? If so, indicate the direction of the induced current and explain your reasoning. If not, explain why not.