Physics 115: Contemporary Physics III

Spring 2013

Homework 6

Due May 23, 2013

- 1. Chabay & Sherwood, Problem 23.P.26.
- 2. Chabay & Sherwood, Problem 23.P.29.
- 3. Chabay & Sherwood, Problem 23.P.38.
- 4. A square with sides of length 2 cm lies in the x y plane with one corner at x = 0, y = 0, the lower side along the x axis and the left side along the y axis. A magnetic field with magnitude $B = (4 \text{ T/m s}^2) y t^2$ points in the z direction. Calculate the magnitude and sense of the emf around the square at t = 3 s.
- 5. A bar of length L, mass m, and resistance R slides along a pair of conducting rails connected at one end a wire of length L and negligible resistance, forming a closed rectangle of width L. The plane of the rectangle is inclined at an angle θ to the horizontal, so that the (horizontal) bar slides toward the closed end of the rectangle due to gravity. A uniform magnetic field **B** points vertically upward throughout the region of the bar and rails.
 - (a) Show that the steady-state speed of the bar is

$$v = \frac{mgR}{B^2L^2} \frac{\sin\theta}{\cos^2\theta}.$$

- (b) Show that the rate at which the internal energy of the bar is increasing is equal to the rate at which the bar is losing gravitational potential energy.
- (c) Discuss what would happen if **B** pointed down, rather than up.
- 6. An inductor with L = 5 H, a resistor with $R = 15 \Omega$, a battery with emf 10 V, and a switch are connected in series in a circuit loop. A 3 A fuse is mistakenly connected to the circuit *in parallel* with the resistor. The fuse has zero resistance if the current through it is less than 3 A, but when the current reaches 3 amp the fuse "blows" and subsequently has infinite resistance. The switch is closed and current begins to flow.
 - (a) Determine the time at which the fuse blows.
 - (b) What is the final current through the inductor?
 - (c) Draw a graph of the current I through the inductor as a function of time. Indicate the time at which the fuse blows.