* **49.** (II) Assuming the Earth's magnetic field averages about 0.50×10^{-4} T near the surface of the Earth, estimate the total energy stored in this field in the first 10 km above the Earth's surface.

* 21–11 *LR* Circuit

* **50.** (II) Determine $\Delta I/\Delta t$ at $t = 0$ (when the battery is connected) for the *LR* circuit of Fig. 21–33 and show that if I continued to increase at this rate, it would reach its maximum value in one time constant.

* **51.** (III) After how many time constants does the current in Fig. 21–33 reach within (*a*) 10%, (*b*) 1.0%, and (*c*) 0.1% of its maximum value?

* **52.** (III) Two tightly wound solenoids have the same length and circular cross-sectional area. But solenoid 1 uses wire that is half as thick as solenoid 2. (*a*) What is the ratio of their inductances? (*b*) What is the ratio of their inductive time constants (assuming no other resistance in the circuits)?

* 21–12 AC Circuits and Reactance

* **53.** (I) What is the reactance of a 7.20-μF capacitor at a frequency of (*a*) 60.0 Hz, (*b*) 1.00 MHz?

* **54.** (I) At what frequency will a 22.0-mH inductor have a reactance of 660 Ω?

* **55.** (I) At what frequency will a 2.40-μF capacitor have a reactance of 6.70 kΩ?

* **56.** (II) Plot a graph of the reactance of a 1.0-μF capacitor as a function of frequency from 10 to 1000 Hz.

* **57.** (II) Plot a graph of the reactance of a 1.0-mH inductor as a function of frequency from 100 to 10,000 Hz.

* **58.** (II) Calculate the reactance of, and rms current in, a 160-mH radio coil connected to a 240-V (rms) 10.0-kHz ac line. Ignore resistance.

* **59.** (II) An inductance coil operates at 240 V and 60.0 Hz. It draws 12.8 A. What is the coil's inductance?

* **60.** (II) (*a*) What is the reactance of a well-insulated 0.030-μF capacitor connected to a 2.0-kV (rms) 720-Hz line? (*b*) What will be the peak value of the current?

* 21–13 *LRC* Circuits

* **61.** (I) A 30-kΩ resistor is in series with a 45-mH inductor and an ac source. Calculate the impedance of the circuit if the source frequency is (*a*) 50 Hz, and (*b*) 3.0×10^4 Hz.

* **62.** (I) A 3.5-kΩ resistor and a 4.0-μF capacitor are connected in series to an ac source. Calculate the impedance of the circuit if the source frequency is (*a*) 60 Hz, and (*b*) 60,000 Hz.

* **63.** (I) For a 120-V rms 60-Hz voltage, an rms current of 70 mA passing through the human body for 1.0 s could be lethal. What must be the impedance of the body for this to occur?

* **64.** (II) What is the resistance of a coil if its impedance is 235 Ω and its reactance is 135 Ω?

* **65.** (II) What are the total impedance, phase angle, and rms current in an *LRC* circuit connected to a 10.0-kHz, 725-V (rms) source if $L = 22.0$ mH, $R = 8.70$ kΩ, and $C = 6250$ pF?

* **66.** (III) A 2.5-kΩ resistor in series with a 420-mH inductor is driven by an ac power supply. At what frequency is the impedance double that of the impedance at 60 Hz?

* **67.** (III) (*a*) What is the rms current in an *RL* circuit when a 60.0-Hz 120-V rms ac voltage is applied, where $R = 1.80$ kΩ, and $L = 350$ mH? (*b*) What is the phase angle between voltage and current? (*c*) What are the rms voltage readings across R and L?

* **68.** (III) (*a*) What is the rms current in an *RC* circuit if $R = 8.80$ kΩ, $C = 1.80$ μF, and the rms applied voltage is 120 V at 60.0 Hz? (*b*) What is the phase angle between voltage and current? (*c*) What are the voltmeter readings across R and C?

* 21–14 Resonance in AC Circuits

* **69.** (I) A 3500-pF capacitor is connected to a 55.0-μH coil of resistance 3.00 Ω. What is the resonant frequency of this circuit?

* **70.** (I) The variable capacitor in the tuner of an AM radio has a capacitance of 2800 pF when the radio is tuned to a station at 580 kHz. (*a*) What must be the capacitance for a station at 1600 kHz? (*b*) What is the inductance (assumed constant)?

* **71.** (II) An *LRC* circuit has $L = 14.8$ mH and $R = 4.40$ Ω. (*a*) What value must C have to produce resonance at 3600 Hz? (*b*) What will be the maximum current at resonance if the peak external voltage is 150 V?

General Problems

72. Suppose you are looking at two current loops in the plane of the page as shown in Fig. 21–53. When switch S is thrown in the left-hand coil, (*a*) what is the direction of the induced current in the other loop? (*b*) What is the situation after a "long" time? (*c*) What is the direction of the induced current in the right-hand loop if that loop is quickly pulled horizontally to the right?

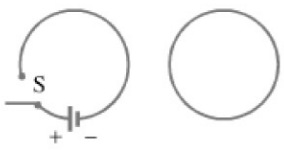

FIGURE 21–53
Problem 72.

73. A square loop 24.0 cm on a side has a resistance of 5.20 Ω. It is initially in a 0.665-T magnetic field, with its plane perpendicular to $\vec{\mathbf{B}}$, but is removed from the field in 40.0 ms. Calculate the electric energy dissipated in this process.

74. A high-intensity desk lamp is rated at 45 W but requires only 12 V. It contains a transformer that converts 120-V household voltage. (*a*) Is the transformer step-up or step-down? (*b*) What is the current in the secondary coil when the lamp is on? (*c*) What is the current in the primary coil? (*d*) What is the resistance of the bulb when on?