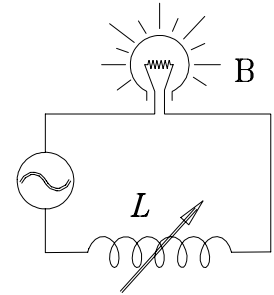# Physics 108 Assignment # **10:**
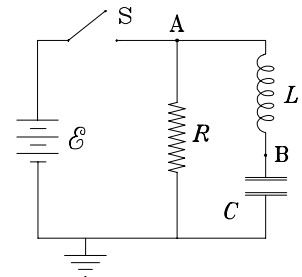
AC CIRCUITS & EM WAVES

Wed. 16 Mar. 2005 — finish by Wed. 23 Mar.

1. **DIMMER SWITCH**:   A typical "light dimmer" switch consists of a variable inductor L connected in series with the light bulb B as shown in the diagram on the right. The power supply produces 120 V (rms) at 60.0 Hz and the light bulb is marked "120 V, 100 W." Assume that the light bulb is a simple resistor whose resistance does not depend on its temperature.

    (*a*)   What maximum inductance L is required if the power in the light bulb is to be varied by a factor of five?

    (*b*)   Could one use a variable resistor in place of the variable inductor? If so, what maximum resistance R would be required? Why isn't this done? (Variable resistors [rheostats] are generally cheaper than variable inductors.)

2. ***LCR* CIRCUIT TIME-DEPENDENCE**:   In the circuit shown, the battery has negligible internal resistance. The switch **S** is closed for a long time, then opened. Describe *qualitatively* what happens in the circuit after the switch is closed and then after it is opened again, for two cases:

    (*a*) $R/2L > 1/\sqrt{LC}$ and

    (*b*) $R/2L < 1/\sqrt{LC}$.

3. **ELECTROMAGNETIC WAVE**:   The electric field associated with a plane electromagnetic wave is given by
$$E_x = 0, \quad E_y = 0 \quad \text{and} \quad E_z = E_0 \sin[k(x - ct)],$$
    where $E_0 = 2.34 \times 10^{-4}$ V/m and $k = 9.72 \times 10^6$ m^{-1}. The wave is propagating in the $+x$ direction.

    (*a*)   Write expressions for all three components of the magnetic field associated with the wave.

    (*b*)   Find the wavelength of the wave.