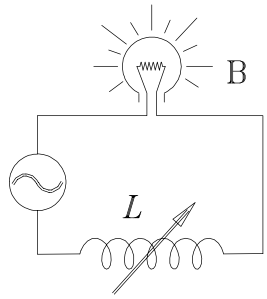
THE UNIVERSITY OF BRITISH COLUMBIA

Physics 122 Assignment # 10:
AC CIRCUITS & EM WAVES

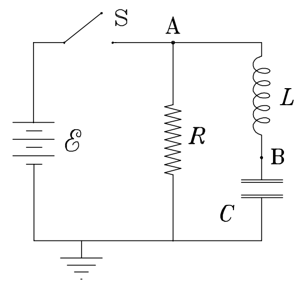
Fri. 15 Mar. 2002 — finish by Fri. 22 Mar.



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.