Series RLC Circuit

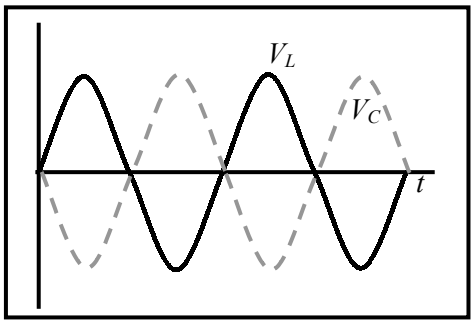
Apparatus

function generator, variable inductor, capacitor, low voltage globe, all wired in series

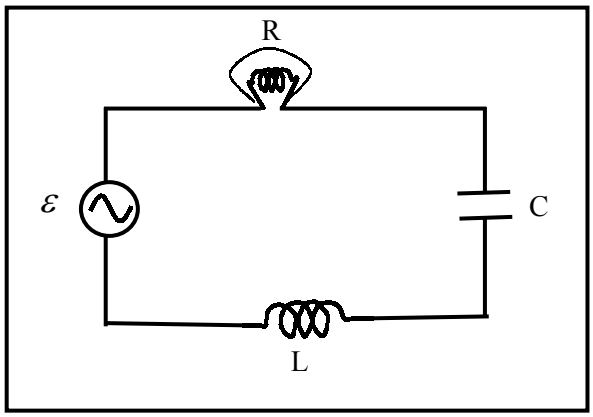
Action

The students vary the frequency of the input from the signal generator while observing the globe. At resonance the globe will be brightest. They then vary the inductance for a fixed input frequency and again look for resonance.

The Physics



The globe acts as a resistor, dissipating energy as heat and light. The voltages across the inductor and the capacitor depend on the reactance of the two components. The reactance, X, depends on the frequency, f: $X_C = 1/ 2\pi fC$ and $X_L = 2\pi fL$.
When $X_c = X_L$, the total voltage drop across L and C is zero, since V_C and V_L are 180^o out of phase and equal in magnitude, cancelling each other out – so $V_L + V_C = 0$, and all the voltage drop is across R. See diagram opposite.
So the impedance of the circuit = R, the resistance of the globe. The current will be a maximum and the bulb will glow most brightly. Varying the inductance, L, of the inductor until $X_c = X_L$ will lead to a similar effect.
Note also that the voltage across the capacitor and inductor are always 180^o out of phase.



Accompanying sheet

Series RLC Circuit

Vary the frequency of the input.
What happens to the globe? Why?

Now vary the inductance of the circuit.
Explain what happens.