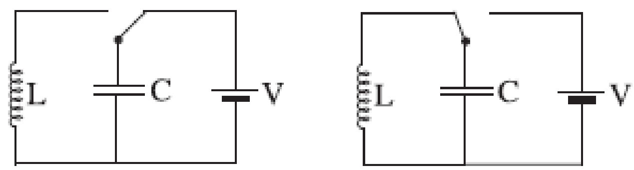
PH 351. Problem set 3. Due Monday, October 17.

1. The figure below shows an LC circuit with a battery to get it started. The capacitor is first charged to a voltage V1 by means of the battery. At time t = 0, the switch is thrown to connect the charged capacitor across the coil. Derive the amplitude and phase constant of the resulting oscillation in the charge on the capacitor.



2. Suppose you have an oscillator with mass m = 1.0 kg attached to a spring with stiffness s = 64 N/m. The mass slides on some oil, so that the frictional force has the form −b $d\psi/dt$.

(a) What value of b would make the amplitude decrease from A to A/e in a time 10 s?

(b) One often defines $\boldsymbol{\gamma = b/m}$ and the Q-value of on oscillator as $\boldsymbol{\omega_0/\gamma}$. That way if the oscillator is very lightly damped, its Q is big. What is the Q value for the oscillator with this value of b?

(c) What value for b would put the oscillator just at the boundary between light damping and heavy damping? (The boundary is called critical damping.)

3. Show that the amplitude of a damped vibration as described in problem 2 is halved in a time $1.39/\gamma$.

4. Show that the successive maxima of ψ for a damped oscillator are separated in time by $\Delta t = 2\pi/\omega f$.

5. The figure below shows an LRC circuit with a battery to get it started. The capacitor is first charged to a voltage V1 by means of the battery. At time t = 0, the switch is thrown to connect the charged capacitor across the coil. Find the charge Q(t) on the capacitor as a function of time t for t > 0. What is the condition on R compared for a given L and C such that the circuit oscillates instead of having Q just go to zero without oscillations? For R such that the current does oscillate, sketch the qualitative behavior of Q(t) exhibited by your solution.