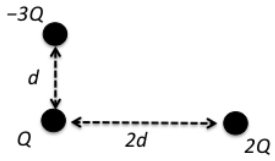
Winter Quarter 2013 – UCSB Physics 24 Final

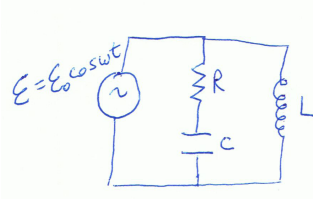
- **Problem 1**



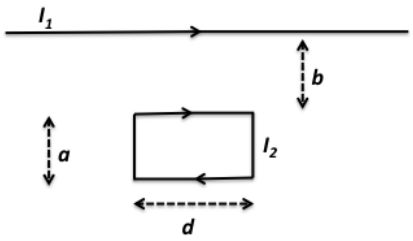
Consider the arrangement of charges shown above. Find the components of the polarization vector. Define the axes as follows: X to the right, Y up, Z out of the page.

- **Problem 2** A muon (mass M) decays into an electron (mass m) and a neutrino (mass=0).
(a) Find the magnitude of the momentum of the electron in the muon rest frame. Call this momentum q.
(b) Now imagine that in the rest frame the electron was emitted in the positive X-direction. Boost the system into a frame where the muon is moving with momentum p' in the positive X-direction. In this frame what is the momentum k' of the neutrino? Leave your answer expressed in terms of q. If you do not know how to do part (a), attempt part (b) taking q as a given.

- **Problem 3**



Consider the circuit in the figure.
(a) Find the current I_1 flowing through the inductor.
(b) Find the current I_2 flowing through the resistor.



- **Problem 4**

  Consider an infinitely long wire carrying current I_1 and a square loop carrying current I_2 as shown in the figure. Find the net magnitude of the force exerted on the loop by the magnetic field created by the long wire.
  Note: the arrows are in the direction of the current flow.

- **Problem 5**

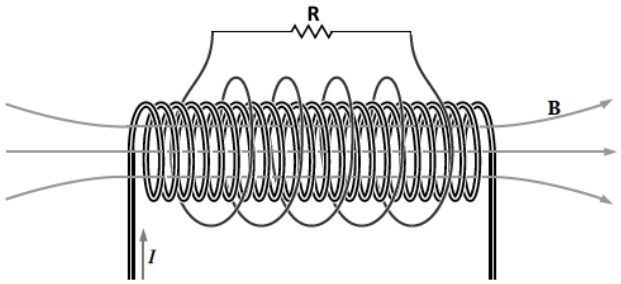
  Refer to the arrangement of wires of problem 4. Find the flux through the loop of the magnetic field created by the long wire.

- **Problem 6**

  A positron (e^+) is the antimatter partner of the electron, i.e., a particle identical to the electron (e^-) but with positive charge.
  A positron of energy E collides with an electron which is at rest. The electron and the positron annhilate into two photons, $e^+e^- \rightarrow \gamma\gamma$. The two photons are measured to emerge from the collision with equal energies E_γ.
  (a) What is E_γ?
  (b) What is the angle made by the momentum vector of one of the two photons and the momentum vector of the incoming positron.
  (Take the mass of one electron or one positron to be m).

- **Problem 7**

  A solenoid of length L and diameter d consists of N turns of wire. A 5-turn coil with negligible resistence is wrapped around the solenoid and connected to a resistor R as shown in the figure.
  The direction of the current in the solenoid is such that the solenoid



magnetic field points to the right. At time $t = 0$ the solenoid current begins to decay exponentially as $I_S(t) = I_0 e^{-\frac{t}{\tau}}$.
(a) What is the direction of the current in the resistor (I_C) as the solenoid current decays. (specify "from left to right" or "or from right to left").
(b) Find $I_C(t)$.
Approximate the solenoid as an ideal infinitely long solenoid...even if it does not look like that in the picture. Neglect the self-inductance of the coil.

- **Problem 8**

  A parallel plate capacitor consists of two circular plates of radius R separated by a distance d. The capacitance is $C = \frac{R^2}{4d}$. The capacitor is being charged by a constant current I.
  (a) find the displacement current density $\vec{J}_d = \frac{1}{4\pi}\frac{\partial \vec{E}}{\partial t}$ between the capacitor plates.
  (b) find the magnetic field between the capacitor plates at a distance r from the axis that joins the centers of the two plates.
  Ignore any effects associated with capacitor edges.