Winter 2014 – UCSB Physics 24 Final

- **Problem 1**

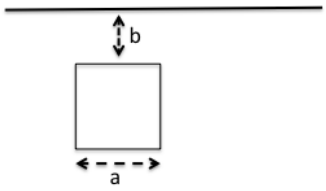
  A pion of mass M and momentum P is traveling in the positive x-direction. It decays into two massless photon. Photon 1 has momentum k_1 and is traveling in the positive x-direction; photon 2 has momentum k_2 and is traveling in the negative x-direction. Find k_1 and k_2 in terms of M and P. You can use $c = 1$.
  Note: k_1 and k_2 are **magnitudes** of momenta, and therefore should be taken as **positive** quantities.

- **Problem 2**

  A spaceship launches probe A with velocity $v_A = 0.8c$ and probe B with velocity $v_B = 0.5c$ (with respect to the spaceship). An observer in the spaceship sees the that the angle between the directions of the two probes is θ with $\cos\theta = \frac{3}{5}$. What is the magnitude of velocity of probe B as measured by an observer on probe A.

- **Problem 3**

  Consider an infinitely long wire and a square wire loop as shown in the figure. Find the mutual inductance of the wire and the loop.



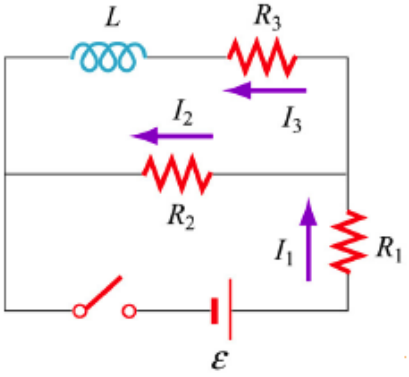
- **Problem 4**

  An infinitely long circular wire of radius R and conductivity σ carries a current $I = \alpha t$, where α is a constant and t is time. The current is distributed uniformly inside the wire. Reminder: conductivity is defined a $\vec{J} = \sigma\vec{E}$, where $\vec{J}$ is the current density and $\vec{E}$ is the electric field.
  (a) Find the magnitude of the displacement current as a function of time at a distance r from the center of the wire, with $r < R$.
  (b) Find the magnitude of the magnetic field as a function of time at a distance r from the center of the wire, with $r > R$.

- **Problem 5**

  Consider the circuit shown in the figure below to the right. Find the currents I_1, I_2, and I_3.

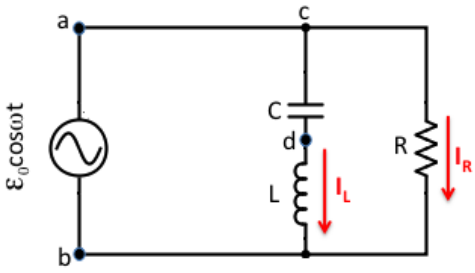
  (a) Immediately after the switch is closed.
  (b) A long time after the switch is closed.



- **Problem 6**

  Consider the circuit shown in the figure below to the right.

  Note: $V_a - V_b = \mathcal{E}_0 \cos \omega t$.
  (a) Find I_R, the current in the resistor.
  (b) Find I_L, the current in the inductor.
  (c) Find $V_c - V_d$, the voltage across the capacitor.



- **Problem 7**

  A conducting bar is sliding at constant velocity v on conducting rails connected to a resistor as shown in the figure. There is a uniform magnetic field B pointing into the paper.
  (a) Find the magnitude of the current in the circuit.
  (b) Find the force that has to be applied externally to maintain the constant velocity v.
  (c) Find the power supplied by this force.