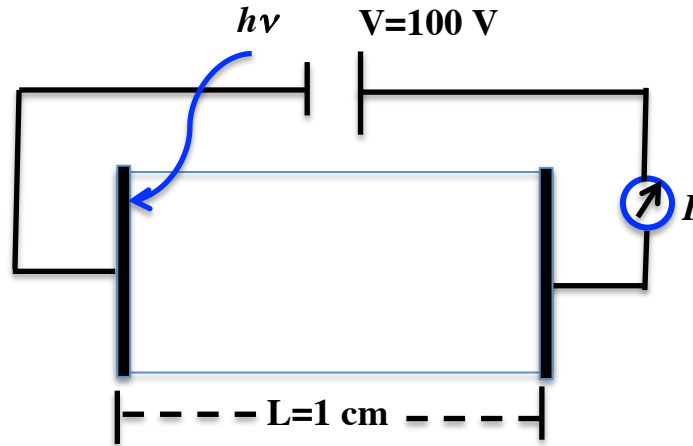# 2013 PhD Qualifying Exam Questions—J. Harris

1. I have the structure illustrated here with two metal electrodes separated by 1cm and I put it into <u>vacuum</u>. I then illuminate the cathode with a pulse of light.

    a. Is there any requirement on the threshold energy of the photons to measure a current at the anode?
    b. When I measure a current, what is the current density as a function of time? Plot it.
    c. Since the external circuit requires current continuity, how do I explain the current through vacuum?
    d. What is the maximum current density?
    e. What is the length of time (known as the transit time) that there will be a measurable current?

2. I now fill the void between the electrodes with a semiconductor and the electrodes form Ohmic contacts to the semiconductor and I illuminate it with a pulse of light.
    a. Is there any difference in the photon energy from the prior case? Why?
    b. What is the current density in this case? Plot it as a function of time. Why is it different than the prior case?
    c. What is the transit time in this case?

3. The Einstein Relationship is used extensively in describing the transport of carriers in semiconductors.
    a. Do you know what physical foundation or assumptions are to derive this relationship?
    b. Can you derive of describe how to simply derive the Einstein Relationship?
    c. Would this apply in the description of transport at very high electric fields?