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Qualifier Exam Questions – Week of 01/23/2006

NAME:

1. (5min) Sketch the band diagram of an npn bipolar transistor in the linear regime. Draw the quasi Fermi levels. Define current gain and explain what limits it. What are some of the tricks I can use to improve the current gain of this device?

2. (3min) I have an LED in a dark room. I bias the LED at a voltage just below the bandgap E_G (in eV) and see efficient light emission with wavelength λ=1240/E_G (in nm) (photon energy = E_G).

Why do I find this strange? What is happening?

3. (3min) Suppose I have two parallel plates. One is heated to a high temperature, say 1800K. The other plate is at room temperature: 300K. Between the plates there is a vacuum.

Can you sketch the current-voltage characteristics of this two-terminal device?

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Consider a pn-junction of an ideal material (only recombination mechanism is radiative recombination). When you slightly forward bias this diode (say V<bandgap/2), will you see light emission? If so, why and how?

If you now consider this pn-junction configures as above, perhaps slightly forward biased, in close proximity to another pn junction that is operated as a solar cell. Now suppose I heat up the LED (first pn junction) using sunlight and use the light generated by this LED to power the solar cell. Is this a good idea for an energy conversion device from sunlight to electrical energy?