2016 PhD Quals Questions
J. S. Harris

1. Can you first tell me how a solar cell works? On an I-V diagram can you identify the different parameters by which we characterize solar cells under illumination?

2. There is a famous paper by Shockley and Queisser defining a limit efficiency for solar cells. Upon what parameter of the solar cell does the limit efficiency depend? Can you illustrate on an energy band diagram the bandgap-efficiency tradeoff and why there is a "limit efficiency"? How is this reflected in the quantum efficiency vs wavelength or energy for the solar cell. What happens to the energy that isn't converted? Would a solar cell illuminated with the same number of photons as from the sun, but from a LED produce the same, greater of lower output power? Would it have a higher conversion efficiency than when illuminated by the sun? Why?

3. What strategies might you suggest to overcome this limit and significantly increase solar cell efficiency?

4. Can you sketch on an energy band diagram and explain how each of these strategies works? Which has proven successful and which unsuccessful and why?