

**2009 PhD Quals Questions**  
**J. S. Harris**

1. What is the Depletion Approximation for a p/n junction?
2. Can you draw the charge distribution, electric field and potential for an abrupt p/n junction under the depletion approximation?
3. Can you draw an energy band diagram for the p/n junction, including the vacuum level?
4. What happens to the above sketches if I now insert a plane of positive charge right at the p/n junction interface which is exactly  $1/2(N_d x_n)$  of the original depletion region. Go back to your original drawings for the idealized p/n junction and using a different color pen, draw in the charge distribution, electric field and potential for the new situation.
5. Please draw the I-V characteristic for the first “ideal” junction at room temperature. What would the I-V characteristic look like at  $-100^\circ\text{C}$  and explain the differences based upon the physical processes for current in the diode.
6. Would there be any significant differences between the I-V characteristic for the “ideal” diode and the one where we introduced the sheet of charge? Why or why not?
7. If I have a p/N heterojunction in which the bandgap of the n-region is 1.5 eV and that of the p-region is 1.0 eV and both materials have exactly the same electron affinity. Draw the energy band diagram for this p/N heterojunction, including the vacuum level. Why is there a discontinuity in the valence band and not the conduction band?