Tutorial Sheet – Lecture 15

Excitons and Free Carriers

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1) Briefly describe, in your own words, what an exciton is. What is the difference between a Wannier-Mott and Frenkel exciton?

2) InP has a relative permittivit ε_r=12.5, effective masses m_e^*= 0.08m_o, m_h^*= 0.6m_o, and a unit cell size of 0.587nm. Calculate;
   a. The exciton Rydberg energy
   b. The exciton Bohr radius
   c. The energy difference between the n=1 and n=2 exciton

   Estimate;
   d. The number of unit cells contained within the orbit of the n=1 exciton
   e. The temperature range over which you would expect this exciton to be stable
   f. The Mott density for excitons in InP

3) Describe in your own words, using figures as necessary, excitonic effects upon the absorption spectrum of a semiconductor.

4) Describe in your own words, using figures as necessary, the effect of an electric field on a bulk semiconductor material.

5) Describe in your own words, using figures as necessary, the reason for an observed shrinkage in the energy gap of a semiconductor under high carrier densities.

Constants you may need -

Rydberg energy of the atom R_H= 13.6 eV
Bohr radius of the hydrogen atom (a_H=5.29 x10^{-11} m)
Boltzman constant =8.617 x10^{-5} eVK^{-1}