ECE 3040
Dr. Doolittle

Homework 1

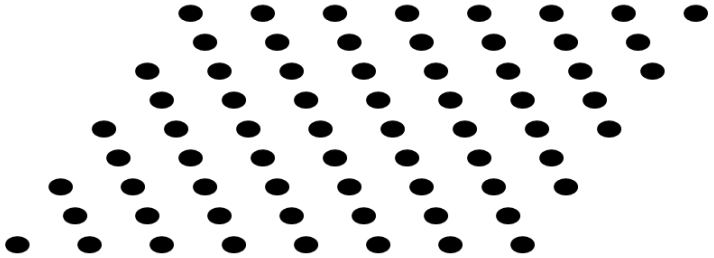
1. Given the ternary compound semiconductor $In_xGa_{1-x}As$,
   a) What is the lattice constant and composition that would result in a 0.85 eV semiconductor?
   b) What is the relationship between lattice constant and chemical bond strength and how does that translate into energy bandgap? You can use the data from Lecture 1.

   Hints:
   Assume that the bonds are covalent in nature.
   Assume that energy bandgaps and lattice constants of compound semiconductors scale linearly (which is a good first-order approximation).
   InAs has a bandgap of 0.36 eV, while GaAs has a bandgap of 1.43 eV.
   InAs has a lattice constant a = 6.06 angstroms, while GaAs has a lattice constant a = 5.65 angstroms.

2. GaP is a III-V compound semiconductor with a zincblende crystal structure and lattice constant a = 5.45 angstroms.
   a) Suppose that instead of the semiconductor it is (Eg=2.24 eV), GaP was a metal and as such, each atom in GaP gave up exactly one electron. What would the electron concentration in the crystal be?
   b) Alternatively, suppose only one-trillionth of the atoms in the crystal gave up an electron. What would the electron concentration be?

   Note: It may be helpful to use the visualization aids on the web page or the images in your text or 3D images online.

3. Using the two-dimensional lattice below, draw and label four different unit cells and identify which one(s) is/are primitive.



4. Describe in three sentences or less how an acceptor atom in silicon can have a stationary (fixed) negative charge and where that negative charge is located at in the region around the acceptor atom.

5. In GaAs (a III-V compound) what is the role (donor or acceptor) and why of:
a) Oxygen substituting for As? b) Si substituting for Ga? c) Si substituting for As? d) Mg substituting for Ga?
Note you may need to reference a periodic table.