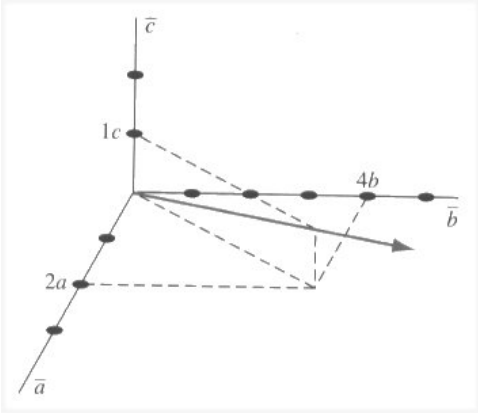
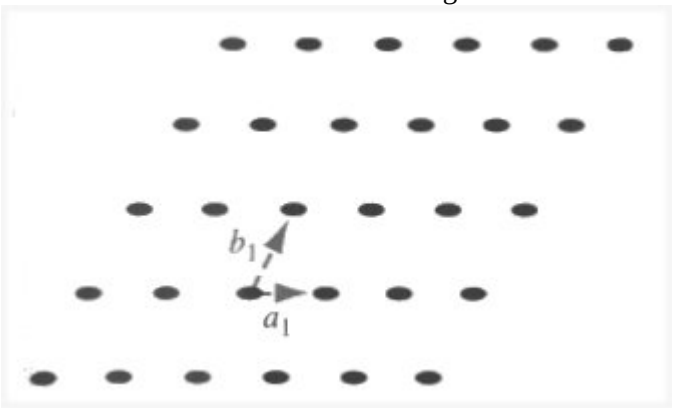
ECE 3080 Homework 1

1) Given the IV-IV compound semiconductor Si_xGe_{1-x} (assume that covalent bonds exist although strictly speaking this is not entirely true) and that energy bandgaps and lattice constants scale linearly, a) What is the lattice constant and composition that would result in a 1.0 eV semiconductor? b) What is the relationship between lattice constant, chemical bond strength, and lattice constant? You can use the data from lecture 1.
2) Given the direction defined below, what is the plane normal to that direction?



3) What is the Miller index of the x-y plane of a cubic crystal?
4) If GaAs, Zinceblende crystal with a lattice constant of 5.65 angstroms were not a semiconductor but instead was a metal where each atom can easily give up one electron, what would the electron concentration in the crystal be? Note, it may be helpful to use the visualization aids on the web page or the images in your text.
5) Given the 2-demensional lattice shown below with unit cell vectors a_1 and b_1, draw and show 4 different unit cells labeling which one/ones are the primitive unit cells.



6) Extend ONE unit cell into the 3rd dimension to give one possible 3D unit cell (draw your unit cell answer).
7) Identify 2 crystalline directions in a cubic system which are perpendicular to the [111] direction. Note that the cosine of the angle T between two arbitrary directions [h_1 k_1 l_1] and [h_2 k_2 l_2] in a cubic crystal is:

$$\cos(\theta) = \frac{h_1h_2 + k_1k_2 + l_1l_2}{\sqrt{\left(h_1^2 + k_1^2 + l_1^2\right)\left(h_2^2 + k_2^2 + l_2^2\right)}}$$

Resulting in the condition for two directions to be perpendicular (cos(T)=0) being: $h_1h_2 + k_1k_2 + l_1l_2 = 0$