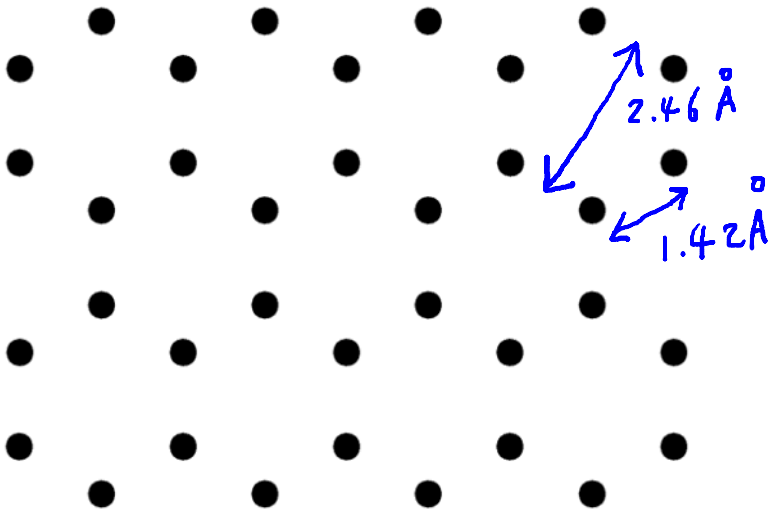
Quiz 2

Tuesday, February 02, 2010

Your name:

1. [10 points] Given the crystal structure as shown in the diagram, (a) define $\vec{a}$ and $\vec{b}$ so that they span the Bravais lattice of this crystal. (b) Find $a = |\vec{a}|, b = |\vec{b}|$ and γ (the angle between $\vec{a}$ and $\vec{b}$). (c) Sketch reciprocal lattice spanning vectors $\vec{a}^*$ and $\vec{b}^*$, correctly oriented relative to $\vec{a}$ and $\vec{b}$. (d) Find the magnitudes of $\vec{a}^*$ and $\vec{b}^*$ and the angle between $\vec{a}^*$ and $\vec{b}^*$. For the magnitudes, it suffices to express them in terms of a (and b, if necessary). [Hint: examine the areas of unit cells for the real lattice and the reciprocal lattice.]



[2nd problem on the back.]

2. [10 points] For a given piece of one dimensional crystal, suppose neutron diffraction gave 100 counts per minute for a Bragg peak. Assume that the diffractometer has a perfect resolution (the incoming beam has an infinite resolution as well as the gratings); if this sounds too good to be true, then suppose that the resolution of the diffractometer is good enough so that it can be subtracted out reliably. When plotting the Bragg peak line shape as a function of k', the wave vector of the diffracted neutron beam, it is found that the line shape has the width $\Delta k' = 0.02\ \text{Å}^{-1}$. With all other things remaining fixed, you replace the crystal with another piece of one dimensional crystal of the same substance, except that the new crystal has only half as many atoms as the original crystal. What would happen to the position, the count-rate and the width of the line shape of the Bragg peak? [You should base your answer on what you learned about the behavior of the lattice sum: $\sum_{\vec{R}} e^{-i\Delta\vec{k}\cdot\vec{R}}$ in the one dimensional (1D) case. Do not confuse $\Delta\vec{k} = \vec{k}' - \vec{k}$ (momentum change due to diffraction) with $\Delta k'$ (the width in k'). No math calculation is asked for here, just use the physical results that you already learned in class and in the homework problem dealing with the above lattice sum in 1D.]