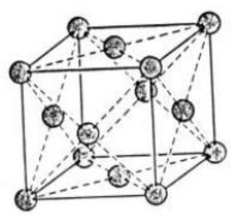
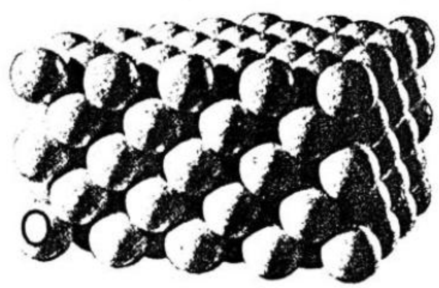
Phys 155, Winter 2011, Homework 1, due Jan 13

Each problem is worth 10 points.

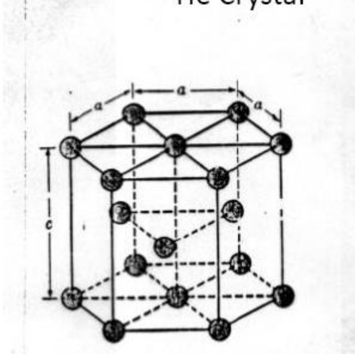
1. (a) Use the semi-classical Bohr-Sommerfeld quantization condition $\oint pdq = nh$ (the integral is over an orbit corresponding to one period) to derive the energy level of a one dimensional simple harmonic oscillator, $E_n = n\hbar\omega$, where ω is the natural frequency of the oscillator. Remember to treat everything with classical mechanics, except for the quantization condition itself. Use the solution $x = A\cos(\omega t + \phi)$ to evaluate the integral. (b) One would generally say that the solution of (a), $E_n = n\hbar\omega$, although incorrect for small n values, is an excellent solution since we are dealing with semi-classical physics (thus high n). Nevertheless, the Bohr-Sommerfeld quantization condition can be, and is often, modified to include a problem-dependent constant γ, $\oint pdq = (n+\gamma)h$, to give the correct result even for small n values. Assuming $n = 0,1,2, \ldots$ what is the value of γ necessary for this problem?
2. For each of the following three crystals, indicate a <u>primitive</u> [unit] cell, and indicate how many <u>atoms</u> there are per [unit] cell. Give brief explanations why.

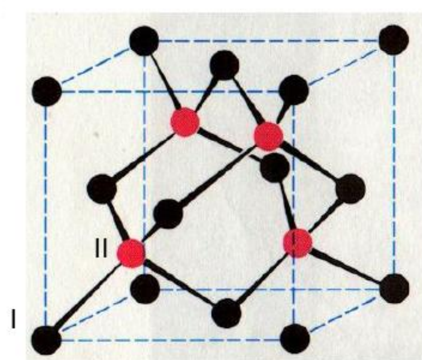
Ar Crystal





He Crystal



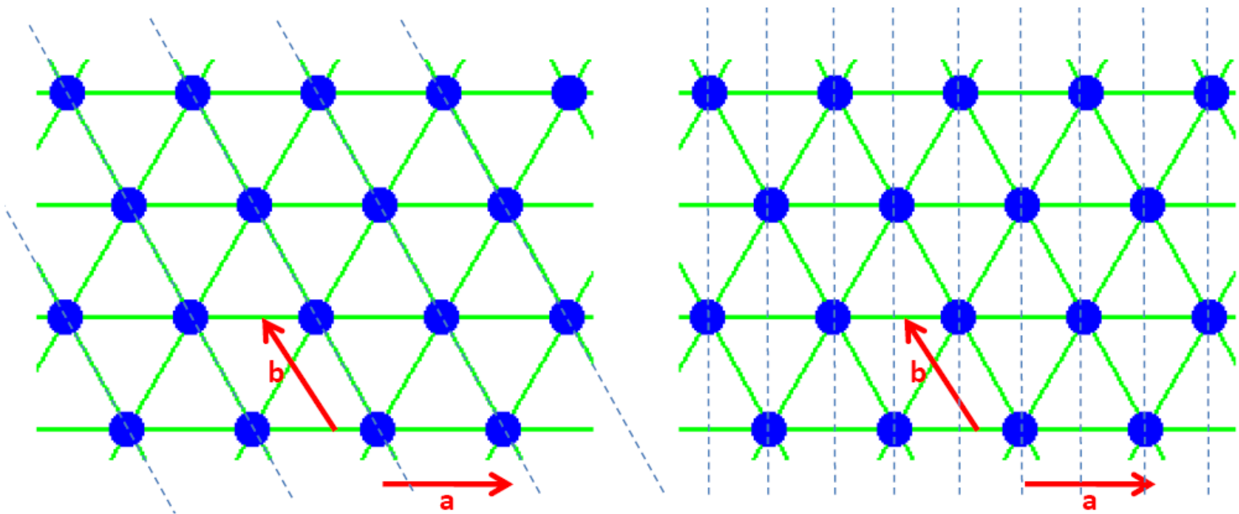


Diamond, if I=II=C (Carbon)
Similarly for Si, Ge
ZnS, if I=Zn, II=S
Similarly for GaAs, InAs, …

3. Consider the planes with indices (100), (110) and (001): the lattice is fcc, and the indices refer to the conventional cubic cell (with side a). What are the indices of these planes

when referred to the primitive axes defined by the three primitive vectors: $\vec{a} = \frac{1}{2}(\hat{x} + \hat{y}), \vec{b} = \frac{1}{2}(\hat{y} + \hat{z}), \vec{c} = \frac{1}{2}(\hat{z} + \hat{x})$.

4. Find Miller indices for the following two sets of lattice lines (dashed lines) for the lattice given. Explain your answer.



5. Show that the c/a ratio of the ideal hexagonal closed-packed structure is $\sqrt{\frac{8}{3}} = 1.633$.