Physics 880.20 Spring Quarter 2008
Dr. Herbst

HOMEWORK ASSIGNMENT # 1
Due: Tuesday, April 8

1. For a tightly packed arrangement (spheres touching), determine the fraction of the volume of a unit cell occupied by the spheres for the following cubes: (a) primitive (b) bcc (c) fcc.

2. For a simple cubic lattice, draw the following high-index planes: (200) (210) (221). For a face-centered cubic lattice, what is the difference if any between (200) and (100)?

3. Derive the dimensions for the smallest unit surface cell for the 110 surface of the simple cubic and fcc cells and the 111 surface for the bcc cell. Indicate in a diagram the second layer as well. Show some perpendicular vectors and their Miller indices.

4. Suppose that there is a barrier to sticking of an adsorbate, which leads to a factor of $\exp(-E_s/kT)$ in the rate of adsorption. If the barrier is 0.1 eV, determine the time needed at 300 K and atmospheric pressure for an adsorbate of 10 amu to produce one monolayer of adsorbate. Use the same site density as used in class.

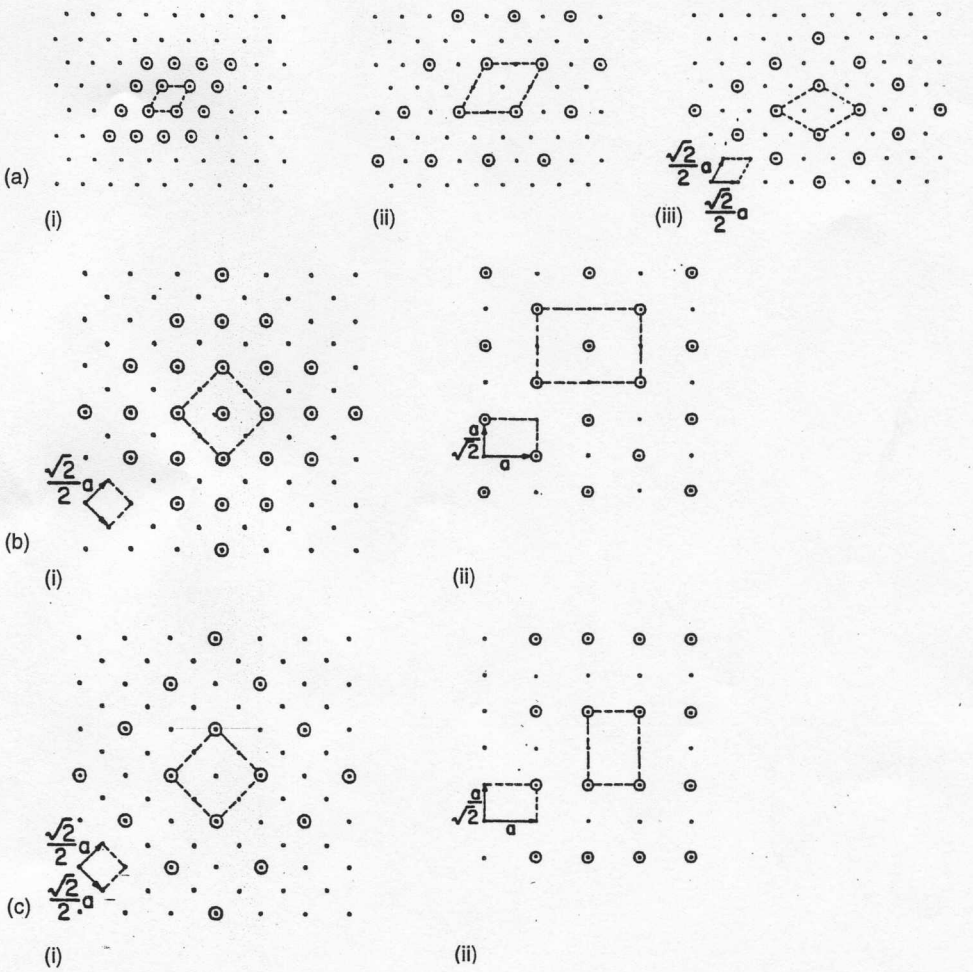
5. Give Woods and matrix notation for the adsorbate structures based on low-index fcc planes on the following page.

6. The Fermi energies of cesium, silver, and aluminum are 1.59, 5.49, and 11.7 eV, respectively. Calculate the density of the free electron gas in each of these metals as well as the Fermi temperature (the Fermi energy in units of K). Calculate the difference between the chemical potential and the Fermi energy for each of these metals at their respective melting points. Look up the electron configurations of the three types of atoms, and take a guess what overlaps or half-filled shells allow them to conduct electricity.

7. Discuss the electron distribution on the surface for a metal and for the semiconductor Si.

8. Find the Fermi level for a two-dimensional free-electron model.

9. Show that the mean vibrational energy per mode for a Debye solid at equilibrium is given by the equation presented in class.


(a)
(i)
(ii)
(iii)
$\frac{\sqrt{2}}{2}a$
$\frac{\sqrt{2}}{2}a$
(b)
(i)
$\frac{\sqrt{2}}{2}a$
(ii)
$\frac{a}{\sqrt{2}}$
a
(c)
(i)
$\frac{\sqrt{2}}{2}a$
$\frac{\sqrt{2}}{2}a$
(ii)
$\frac{a}{\sqrt{2}}$
a