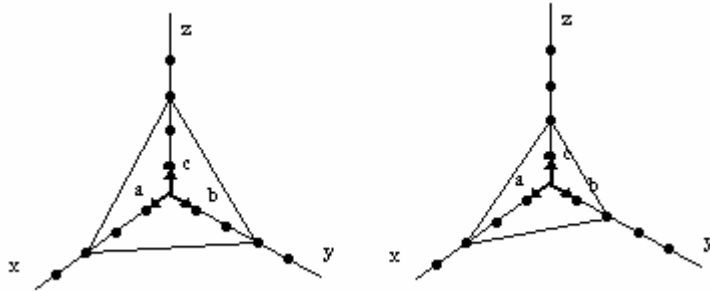


- 1) (a) Label the planes illustrated in figure.
- (b) Draw equivalent $\langle 1\ 1\ 1 \rangle, \langle 1\ 0\ 0 \rangle, \langle 1\ 1\ 0 \rangle$ directions in a cubic lattice; use a unit cube for illustrating each set of equivalent directions.



- 2) Show that the maximum fractions of the unit cell volume that can be filled by hard spheres in the sc, bcc, and diamond lattices are 0.52, 0.68, and 0.34, respectively.
- 3) Calculate the gap of Si and plot of n_i vs. $1000/T$. *Hint:* the slope can not be measured directly from a semi logarithmic plot; read the value from two points on the plot and take the natural logarithm as needed for the solution.
- 4) Show that the minimum conductivity of a semiconductor sample occurs when

$$n_0 = n_i \sqrt{\frac{\mu_p}{\mu_n}}$$

- 5) A Ge sample with $n_0 = 10^{17} \text{ cm}^{-3}$ is optically excited at 300K such that $g_{op} = 10^{20} \text{ EHP / cm}^3 \text{ s}$ and $\tau_n = \tau_p = 10 \mu\text{s}$. What is the separation for the quasi-fermi levels ($F_n - F_p$)? Draw a band diagram.