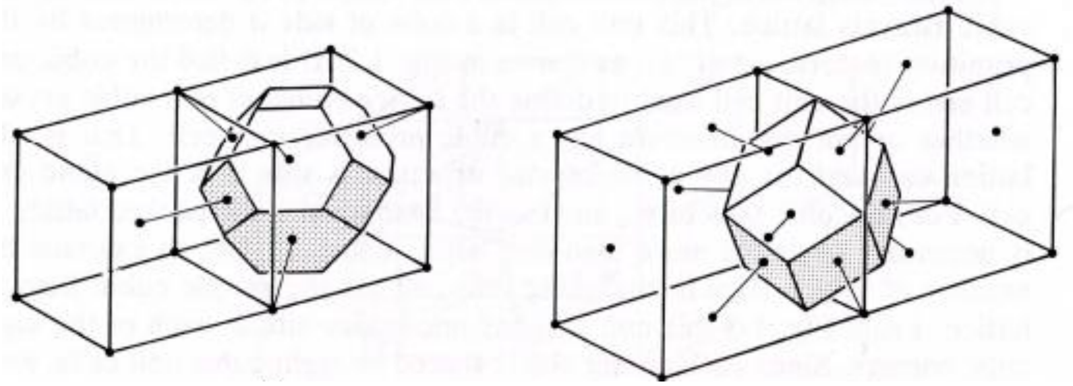
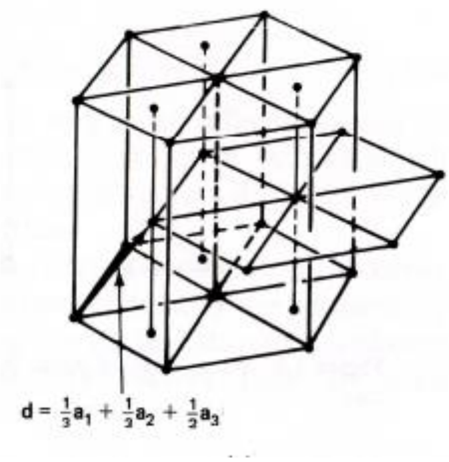
Homework #1

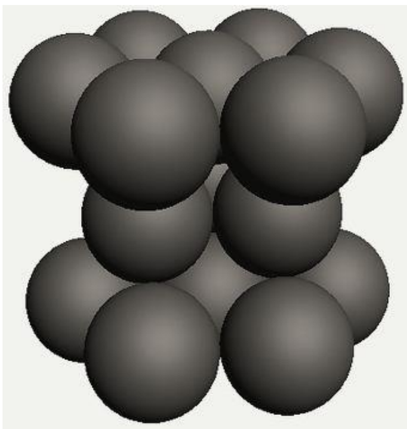
Due: Mar. 27 (M)

1. (a) Show that every edge of the Wigner-Seitz unit cell for the body-centered cubic lattice in Fig. 1.8(a) has the length $\sqrt{2}a/4$.
(b) In the face-centered cubic Wigner-Seitz unit cell of Fig. 1.8(b), show that the two diagonals of each face are in the ratio $\sqrt{2}$:1.



2. Show that in the hexagonal close-packed structure the ideal *c/a* ratio is $\sqrt{8/3}$.





3. Show that the reciprocal lattice for the face-centered cubic lattice with primitive vectors

$$\mathbf{a}_1 = (a/2)(\hat{y} + \hat{z}), \qquad \mathbf{a}_2 = (a/2)(\hat{x} + \hat{z}), \qquad \mathbf{a}_3 = (a/2)(\hat{x} + \hat{y})$$

is body-centered cubic with primitive cell vectors

$$\mathbf{b}_1 = \frac{2\pi}{a}(-\hat{x} + \hat{y} + \hat{z}), \qquad \mathbf{b}_2 = \frac{2\pi}{a}(\hat{x} - \hat{y} + \hat{z}), \qquad \mathbf{b}_3 = \frac{2\pi}{a}(\hat{x} + \hat{y} - \hat{z})$$

4. Find maximum fraction occupied for SC, BCC, FCC and Diamond lattices.

5. Show that a vector $\mathbf{R}_2$ defined by the following

$$\mathbf{R}_2 = (n_1 - pl)\mathbf{a}_1 + (n_2 - pl)\mathbf{a}_2 + [n_3 + p(h + k)]\mathbf{a}_3 \qquad (1.28)$$

has the same projection of the vector $\mathbf{R}_1$ along the direction of the vector $\mathbf{K}$ given as (1.27)

$$|\mathbf{R}_1| \cos \theta_1 = \frac{2\pi N}{|\mathbf{K}|} \qquad (1.27)$$

6. Directions are given in the top left picture for Wurtzite GaN. Find exact Miller indices for the following 4 planes, (1) to (4).