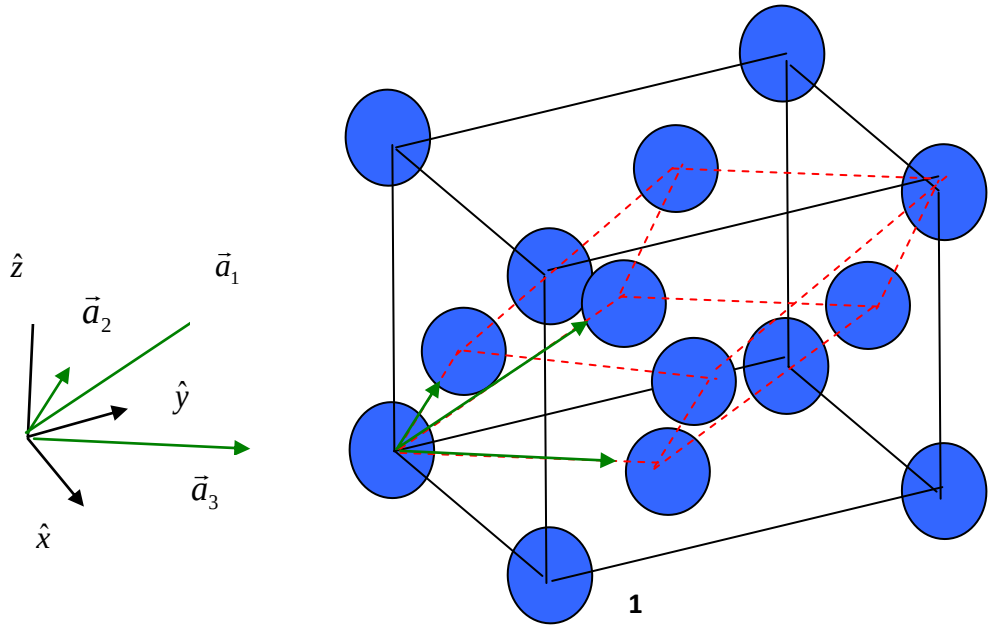
Work Sheet # 2

1. The packing fraction is a number used to indicate how tightly atoms are packed in a given structure. Find the packing fraction for a simple cubic, body-centered cubic, and face-centered cubic lattices.
[Answer: 52%, 68% and 74%, respectively.]

2. Find the edge of primitive cell and its corresponding volume of the following structures
   a) Bcc
   b) Fcc

3. If a set of primitive vectors for face-centered-cubic (fcc) lattice is given by: $\vec{a}_1 = \frac{a}{2}(\hat{y}+\hat{z})$, $\vec{a}_2 = \frac{a}{2}(\hat{x}+\hat{z})$ and $\vec{a}_3 = \frac{a}{2}(\hat{y}+\hat{x})$, as shown in the figure, together with Cartesian axes. Find the position $\vec{R}$ of lattice point 1 in terms of the primitive vectors.



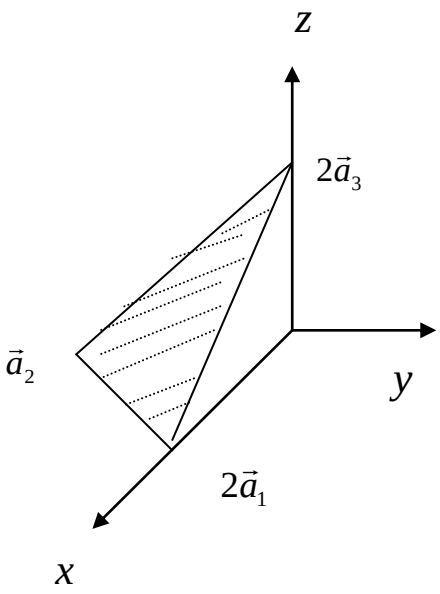
4. A set of primitive lattice vectors for a body-centered cubic (bcc) Bravais lattice is given by $\vec{a}_1 = \frac{a}{2}(\hat{y}+\hat{z}-\hat{x})$, $\vec{a}_2 = \frac{a}{2}(\hat{z}+\hat{x}-\hat{y})$ and $\vec{a}_3 = \frac{a}{2}(\hat{y}+\hat{x}-\hat{z})$. Show that such a choice of primitive vectors can entirely describe the bcc structure lattice.

The followings are MCQ's. Please choose the correct answer:

5. Which of the following statements is correct for the Bravais lattice:
   a. The three primitive vectors that form the Bravais lattice must be perpendicular to each other.
   b. All lattice points (or lattice sites) and the corresponding atoms are not necessarily equivalent and of the same kind.
   c. It is a typical two dimensional lattice that can be generated by any two vectors.
   d. Bravais lattice is an infinite array of discrete points with an arrangement and orientation that appear the same no matter from which orientation you look at it.
   e. Bravais lattice is a periodic structure of points that can be constructed by stacking layers of atoms and does not need any kind of vectors to generate it.

6. The notation that refers to a family of six equivalent planes in a cubic lattice is
   a. $< 100 >$ b. $\{100\}$ c. (100) d. [100] e. $\pm x, \pm y, \pm z$

7. A plane, in a cubic lattice, together with its intercept values are shown in the figure. The Miller indices (*h k l*) of the plane are
   a. (202) b. $(2\bar{1}2)$ c. $(1\bar{2}1)$ d. $(2\bar{2}1)$ e. $(1\bar{2}2)$



8. The first nearest neighbor distance (in terms of the lattice constant a) for the face-centered-cubic (fcc) structure is *equal to*

a. a b. $\frac{1}{\sqrt{2}}a$ c. $\frac{\sqrt{3}}{4}a$ *d.* $\sqrt{2a}$ *e.* $\frac{a}{2}$

9. Hexagonal-closed packed and face-centered cubic structures are considered as the most highly dense crystalline structures because
   a. they have stacking layers in their building.
   b. they have the largest coordination numbers and packing fraction values.
   c. they have the largest atoms in their structures.
   d. they have the smallest atoms in their structures.
   e. the bonds between atoms are very tight and short.

10. Which of the following statements is correct?
   a. In most cases, positions and directions are indexed in terms of primitive rather than conventional lattice vectors, while planes are indexed in terms of conventional lattice vectors.
   b. In most cases positions, directions and planes of crystals are indexed in terms of primitive rather than conventional lattice vectors.
   c. In most cases positions, directions and planes of cubic crystal structures are indexed in terms of conventional rather than primitive lattice vectors.
   d. In most cases, planes and directions are indexed in terms of primitive rather than conventional lattice vectors, while positions are indexed in terms of conventional lattice vectors.
   e. In most cases positions, directions and planes of crystals are neither indexed in terms of conventional nor indexed in terms of primitive lattice vectors.