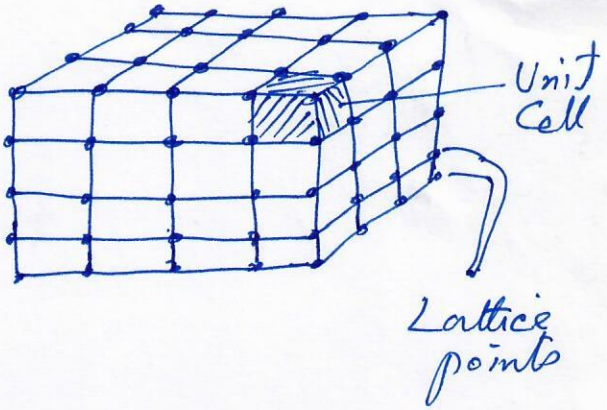
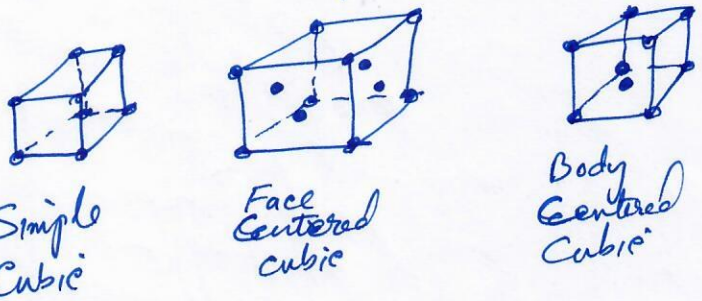
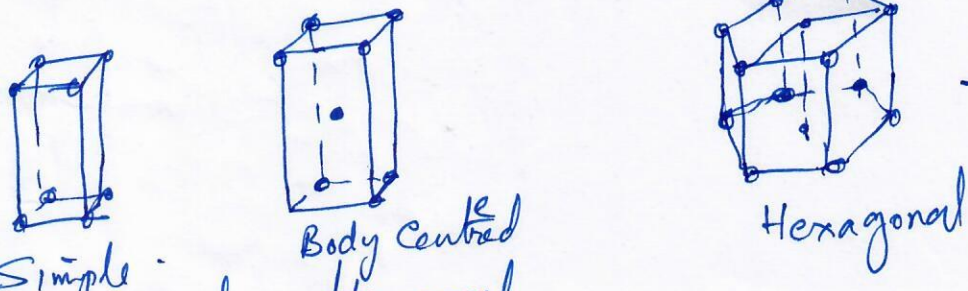
Atomic Arrangements

A lattice is a periodic array of points that define space. The unit cell is a subdivision of the lattice that still retains the characteristics of the lattice.



There are 14 types of unit cells or Bravais lattices in seven crystal structures.





Characteristics of the seven crystal Systems.

Structure	Axes	Angles between axes
Cubic	$a=b=c$	$\alpha=\beta=\gamma=90^0$
Tetragonal	$a=b\neq c$	$\alpha=\beta=\gamma=90^0$
Orthorhombic	$a\neq b\neq c$	$\alpha=\beta=\gamma=90^0$
Hexagonal	$a=b\neq c$	$\alpha=\beta=90^0$, $\gamma=120^0$
Rhombohedral	$a=b=c$	$\alpha=\beta=\gamma\neq90^0$
Monoclinic	$a\neq b\neq c$	$\alpha=\beta=90^0$, $\gamma\neq90^0$
Triclinic	$a\neq b\neq c$	$\alpha\neq\beta\neq\gamma\neq90^0$.

1 angstrom (A^0) $= 10^{-8}$ cm $= 10^{-10}$ m

1 nanometer (nm) $= 10^{-7}$ cm $= 10^{-9}$ m $= 10A^0$

Number of Atoms per Unit Cell

Number of lattice points from the corner positions in one unit cell.

$$\frac{1}{8}\left(\frac{\text{lattice points}}{\text{corner point}}\right)\left(8\,\frac{\text{no. of corners}}{\text{no. of cells}}\right) = 1\ \frac{\text{lattice points}}{\text{unit cell.}}$$

Touching the / Touching the corner = 8

Example-1

Define the number of lattice points per cell in the cubic crystal systems.

In simple cubic (SC) lattice points are located at corners

BCC $\frac{\text{Lattice point}}{\text{Unit cell}} = \frac{1}{8} \times 8 + 1$

$= 1 + 1 = 2$

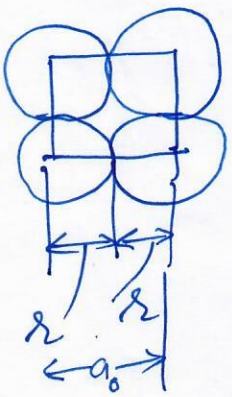
FCC $\frac{\text{Lattice point}}{\text{Unit cell}} = \frac{1}{8} \times 8 + 6 \times \frac{1}{2}$

$= 1 + 3 = 4$

Atomic Radius Versus Lattice Parameters

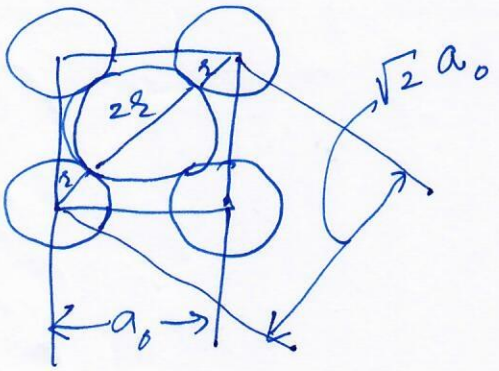
Example

Determine the relationship between the atomic radius and the lattice parameters in SC, BCC, FCC



$a_0 = 2R$

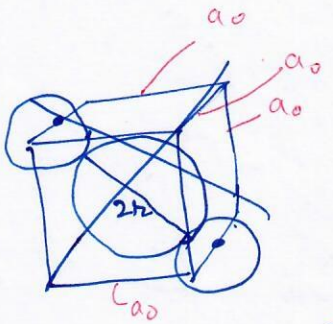
(SC)

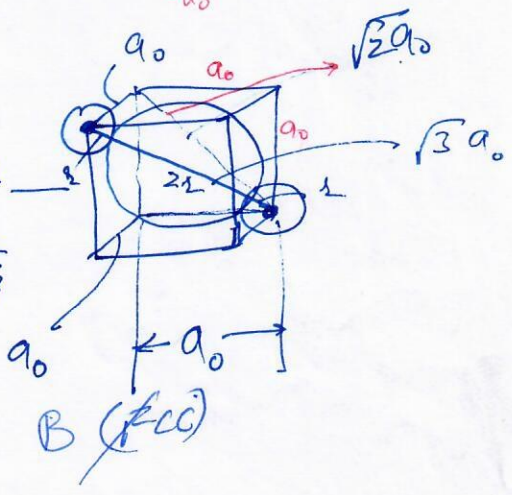


$4R = \sqrt{2}\,a_0$

$a_0 = \frac{4R}{\sqrt{2}}$,

F (BCC)





$\sqrt{3}a_0 = 4R$

$a_0 = \frac{4R}{\sqrt{3}}$

B (BCC)

Example

The atomic radius of iron is 1.24 A°

Calculate the lattice parameters of BCC and FCC

For B.C.C