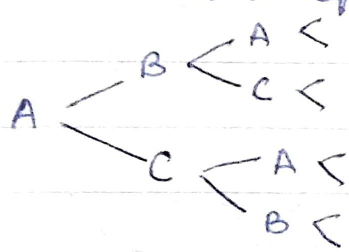
Let us consider building up the next layer on the top of this ~~Closed~~ close - packed layer.

If we try to put the spheres in second layer so that they are vertically on the top of the A spheres. this is an unstable position & the spheres are likely to roll down to the dimples or the triangular voids between the spheres.

There are two kinds of ~~viods~~ voids B & C therefore the next close - packed layer over A layer can be formed by putting all the spheres either on voids B or on the C voids. then the third layer can be put with spheres occupying the C voids or A voids.

Thus any sequence of letters A, B & C, with no two successive letters alike, represent a possible manner of close packing.



$A \neq A$

$B \neq B$

$C \neq C$

Each sphere in any such arrangement is in ~~cot~~ contact with 12 other spheres.

6 in its own layer, 3 in layer above & 3 in layer below

Stacking of A, B, C types of layers such that there is no AA, BB, CC combination.

two stacking sequences, which occur most commonly in crystals -

1. AB | AB | AB | AB | ------ (HCP)

hexagonal ~~do~~ closest packing

& structure is hexagonal close-packed structure.

Zn, Cd, Ti, Mg

Repeat period 2

hcp - 2H structure

2. ABC | ABC | ABC | ---- (CCP).

Cubic closest packing

& structure is cubic close-packed structure

or face ~~centered~~ centred cubic (fcc)

Cu, Al, Si, Au, Pt..

Repeat period 3

ccp → 3C structure

3 ABCB | ABCB | ABCB | ---

hcp → 4H structure

Lanthnum

4. AB ABC BC AC | ABABCBCAC | ----

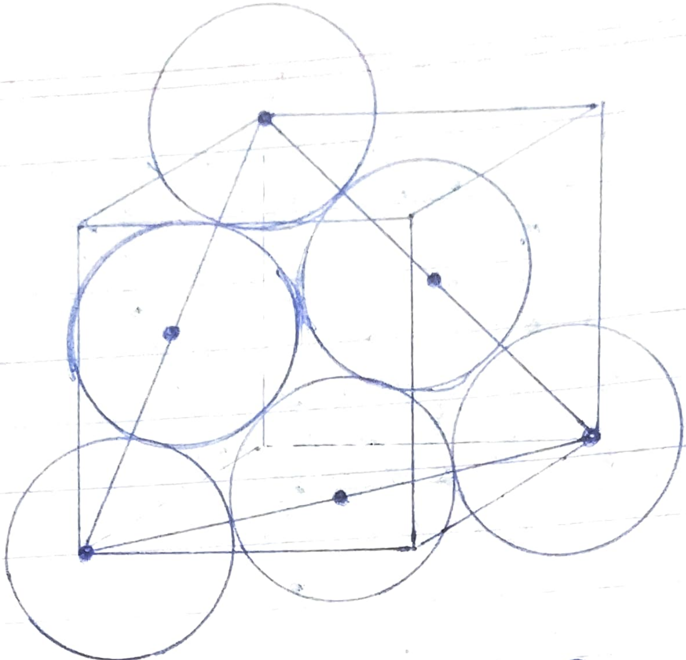
Rhombohedral lattice

Sm - Samarium

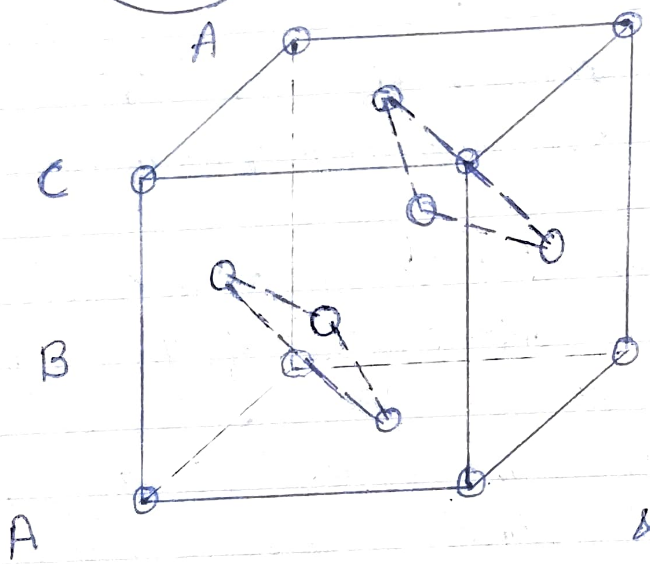
9R structure

either H or R in close packed structure

Rare - C



(111) plane have gol close-packed arrangement of sphere.



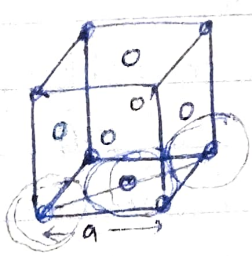
fcc arrangement of atoms same as ABC|ABC| ---

so called fcc close packed structure & so Cubic close packed structure.

the structure is close packed each atom has 12 nearest neighbours

What is packing fraction for 3-D close pack ?

In fcc = 4 atoms per unit cell



direction of closest approach <110>

$4r = \sqrt{2}a$

$a = \frac{4r}{\sqrt{2}}$

$$\text{packing fraction} = \frac{\text{Volume occupied}}{\text{Volume available}}$$

$$= \frac{4 \times \frac{4}{3}\pi r^3}{a^3}$$

$$= \frac{4 \times 4\pi r^3 \times 2\sqrt{2}}{3 \times 4 \times 4 \times 4\, r^3} = \frac{\pi}{3\sqrt{2}} = 0.74$$

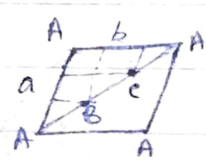
74 % space occupied.

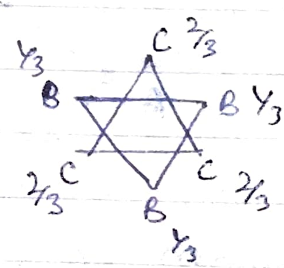
hence for ideally close-packed structure pf = 74%

ABC packing

A	0	0	0
B	$\frac{1}{3}$	$\frac{2}{3}$	$\frac{1}{3}$ ✓
C	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{2}{3}$ ✓

Center			
A	0	0	0
B	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{3}$ ×
C	$\frac{1}{3}$	$\frac{2}{3}$	$\frac{2}{3}$ ×





Out of 82 metallic element
53 are HCP or CCP
20 body centred cubic.

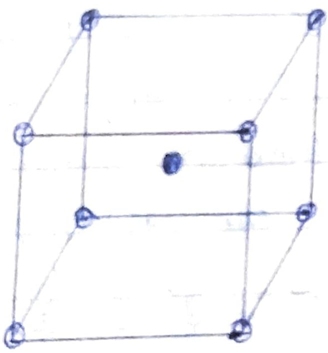
FCC – CCP –
each atom occupies a lattice point
so its structure & lattice are similar.
i.e. motif consist of 1 point

Body centred cubic packing -

Some crystals have arrangements of atoms which do not correspond to close packing.

The most important of these is the arrangement in which each sphere has 8 nearest neighbours.

This give rise to body centred cubic crystal. the unit cell is shown in fig.



the effective no. of atoms or Lattice point in the unit cell is 2

0 0 0
$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$

The atoms toch each other.. along the body diagonal.

$\therefore$ direction of closest approach

<111>

$\therefore \quad 4r = \sqrt{3}\,a \qquad a = \frac{4r}{\sqrt{3}}$

$$\text{Packing fraction} = \frac{\text{Volume occupied}}{\text{Volume available}}$$

$$= \frac{2 \cdot \frac{4}{3}\pi r^3}{a^3}$$

$$= \frac{2 \times 4 \pi r^3 \times 3\sqrt{3}}{3 \times 4 \times 4 \times 4 r^3} = \frac{\sqrt{3}\,\pi}{8} = 0.68$$

28

68% space occupied.

repetition sequence
ABAC | ABAC | ABAC | -

BCC - Metallic arrangement
Na, K, Li
Cr, Mo, Ta, α Fe   Poor conductor

& no. nearest neighbours decreases Directionality increases
& directionality of bonds increases
so covalent character increases
& hence conductivity go down

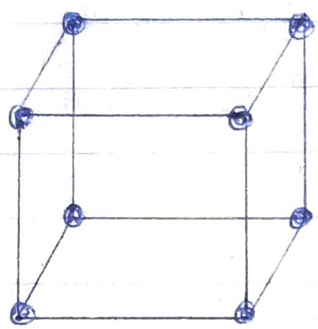
	BCC	FCC
no. of nearest neighbours	8 ($\approx \frac{2}{3} \times 12$)	12
space occupied	68%	74%
		$74 \times \frac{2}{3} \approx 50$

As no. of nearest neighbours in BCC becomes $\frac{2}{3}$rd
but space occupied does not become $\frac{2}{3}$rd
the reason for this is that
It is not only nearest neighbour matter
next nearest neighbours are also matter.

[$BaTiO_3$ - 5 ~~latt~~ atoms per lattice point]
Lattice - regular array, related to geometry of crystal
used to describe structure

Simple cubic structure –

In this structure atoms are situated at the corners of the cube touching each other along the edges.



1 atom per lattice point
no. of lattice point in unit cell = 1
no. of nearest neighbours = 6.
direction of closest approach
<100>

$\therefore$ $2r = a$

$$\text{packing fraction} = \frac{\text{Volume occupied}}{\text{Volume available}}$$

$$= \frac{\frac{4}{3}\pi r^3}{a^3} = \frac{4}{3}\frac{\pi r^3}{8r^3} = \frac{\pi}{6}$$

$= 0.52$

hence 52% space occupied
i.e. crystal is very directional.

Po – Polonium – only metallic element which crystallizes in s.c. structure.

interpenetrating