Declaration :-

I declare that all the questions I shall write for today's assignment will be handwri -tten by me and only

I [redacted] declare that I dont indulge in any kind of copying from others and will answer all questions with sincerity and integrity. If I am copying that will falsely gain me marks I shall be penalized as per the guidelines of the university and may lead to cancellation of that assignment for this course.

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FCC
Face centred cubic

→ No of atoms in unit cell = 4

A cube has 8 corners and 6 faces

$8 \text{ atm} \times \frac{1}{8} = 1 \text{ atom}$

Each atoms consists 1/2 itself to a particular cubic crystal lattice

$6 \text{ atms} \times \frac{1}{2} = 3 \text{ atoms}$

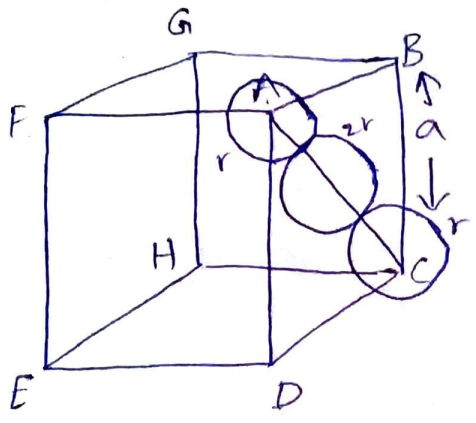
∴ Total no of atoms in FCC Lattice = 4

→ coordination number of FCC unit cell = 12

Because one corner atom is surrounded by 4 faces in x-plane, 4 faces in y-plane 4 faces in z-plane

so. Total = 4+4+4 = 12 Face centred atoms

→ Relation Between a and r



In ΔABC

$AC^2 = AB^2 + BC^2$

$(r+2r+r)^2 = a^2 + a^2$

$16r^2 = 2a^2$

$8r^2 = a^2$

$a = 2\sqrt{2}r$

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→ packing efficiency

$$= \frac{\text{Volume of atoms at unit area}}{\text{Total volume of unit area}} \times 100$$

$$= \frac{4 \times \frac{4}{3}\pi r^3}{a^3} \times 100$$

$$= \frac{4 \times 4/3\ \pi r^3}{16\sqrt{2}\, r^3} = \frac{\pi}{3\sqrt{2}} = 74\%.$$

∴ void space = 26 %.

In an FCC 74% contains atoms
26% contains void space

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BCC

Body centred cubic

→ In BCC 8 atoms are located at 8 corners and 1 atom is present in centre

$$\therefore 8 \times \frac{1}{8} = 1 \text{ atom}$$

$$1 \times 1 = 1 \text{ atom}$$

∴ There are two atoms in Body centred unit cell.

→ coordination number :- ●

The BCC has a coordination number of 8 and contains 2 atoms per unit cell

The simple cube has coordination number of 6 and contains 1 atom per unit cell

→ Relation between edge length (a) and radius of atom (r)

Face diagonal = fd

body diagonal = bd

$$bd^2 = fd^2 + a^2$$

$$= a^2 + a^2 + a^2$$

$$= 3a^2$$

Body diagonal has a length of 4 times that of radius of atom

$$(4R)^2 = 3a^2$$

$$4R = \sqrt{3}\,a$$

$$R = \sqrt{3}\,a/4 \Rightarrow a = 4R/\sqrt{3}$$

→ Packing efficiency

$$\frac{2 \times \frac{4}{3}\pi r^3}{a^3} \times 100$$

$$\frac{\frac{8}{3}\pi r^3}{8\frac{64}{3\sqrt{3}}r^3} \times 100 = \frac{\sqrt{3}}{8} \times \frac{22}{7} \times 100$$

$$= 68.04\ \%$$

Void space = 100 − 68.04

$$= 31.96\ \%$$

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SCC

Simple cubic crystal

→ A simple cubic crystal contains 8 atoms at one corner each

$$\therefore \quad 8 \times \frac{1}{8} = 1 \text{ atm}$$

∴ No. of atoms per unit cell = 1

→ coordination number = 6

→ Relation between r and a

$$a = 2r$$

→ packing efficiency

$$\frac{1 \times \frac{4}{3}\pi r^3}{a^3} \times 100$$

$$\frac{\frac{4}{3}\pi r^3}{2\sqrt{3}} \times 100$$

$$\frac{\pi}{6} \times 100 = 52\%$$

void space = 48%