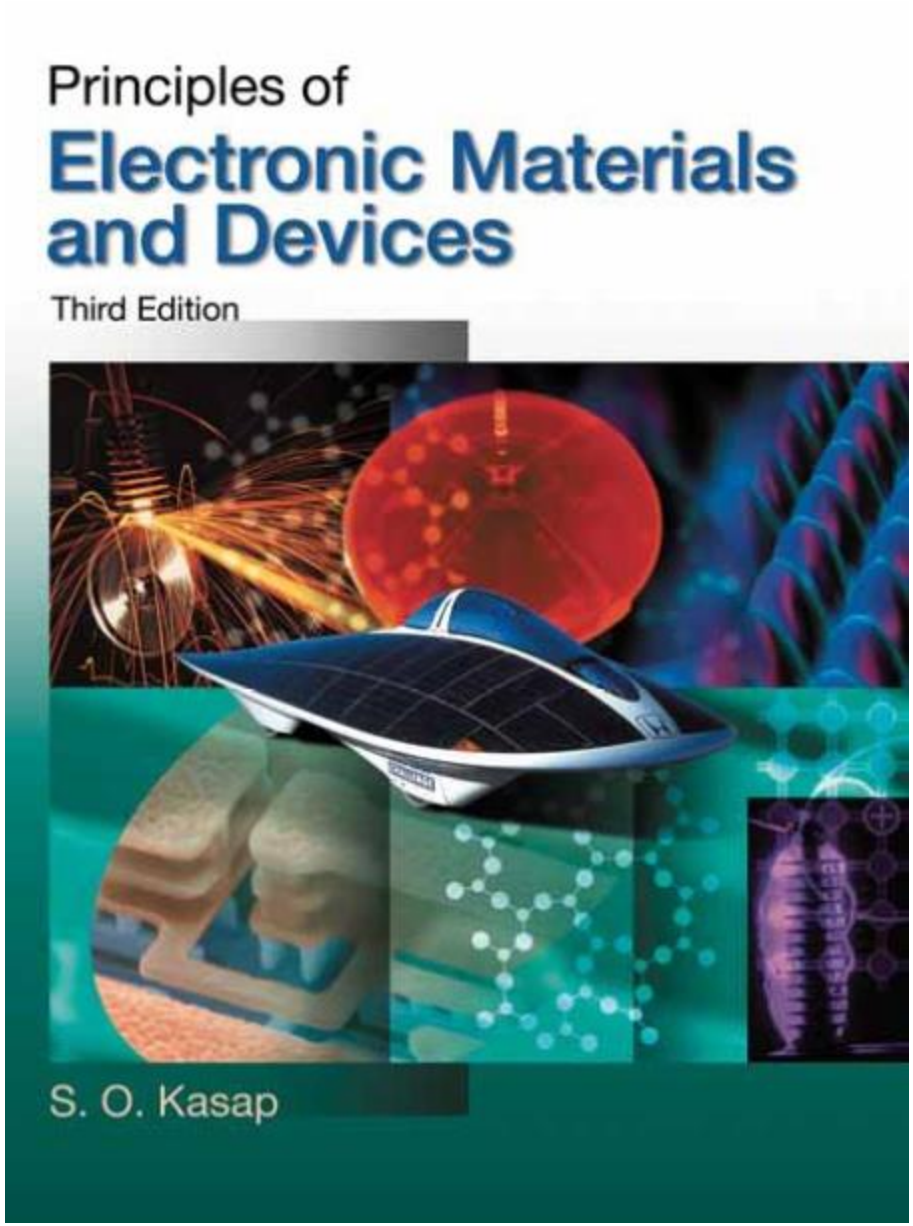
EC210
Solid State Electronics



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Grades

		Week	Points	Total
Quiz I	**Section**	**~ 4th**	**5**	**30**
Exam I	**All classes**	**7th**	**20**	
Lab			**5**	
Quiz II	**Section**	**~10th**	**5**	**20**
Exam II	**All classes**	**12th**	**15**	
Lab			**5**	**10**
Attendance			**5**	

LECTURE 1
Crystal Structure

Kasap

Section 1.8

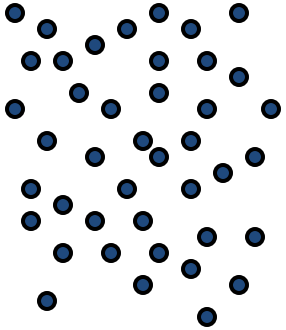
Pages 49 to 60

1-without hexagonal structure and without planar concentration

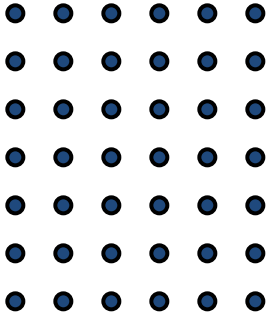
2- Table 1.3 is included except column 3 (Coordination number)

3- Example 1.13 is included. Note that it contains the relation between mass density, the atomic concentration and the atomic mass which will be used in solving some problems of sheet 1.

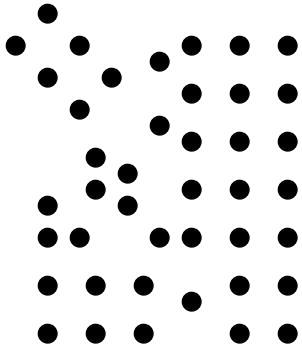
Classification of Materials



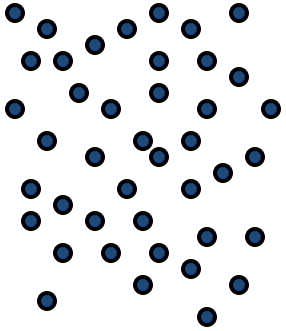
AMORPHOUS STATE



CRYSTALLINE STATE



POLYCRYSTALLINE STATE



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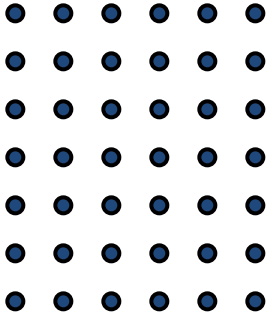
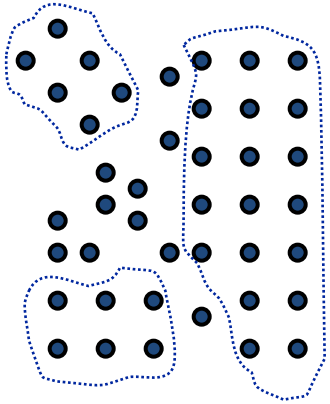
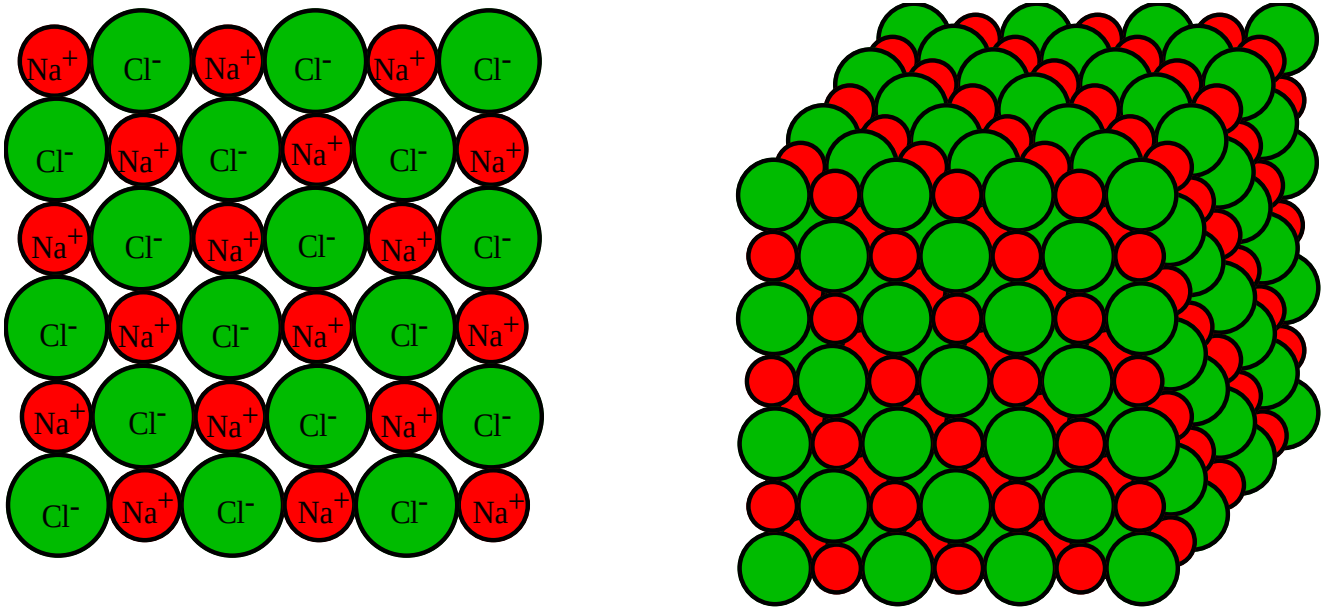


CRYSTALLINE STATE



POLYCRYSTALLINE STATE

Sodium chloride (NaCl)



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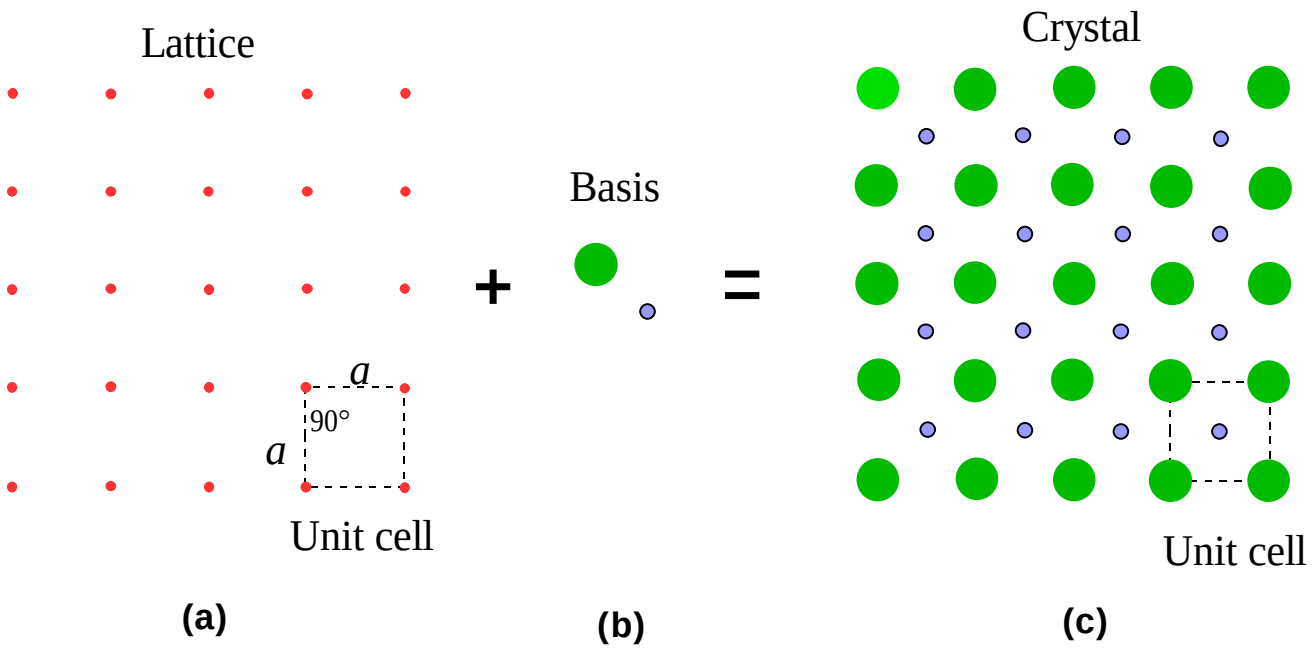
NaCl

Crystals



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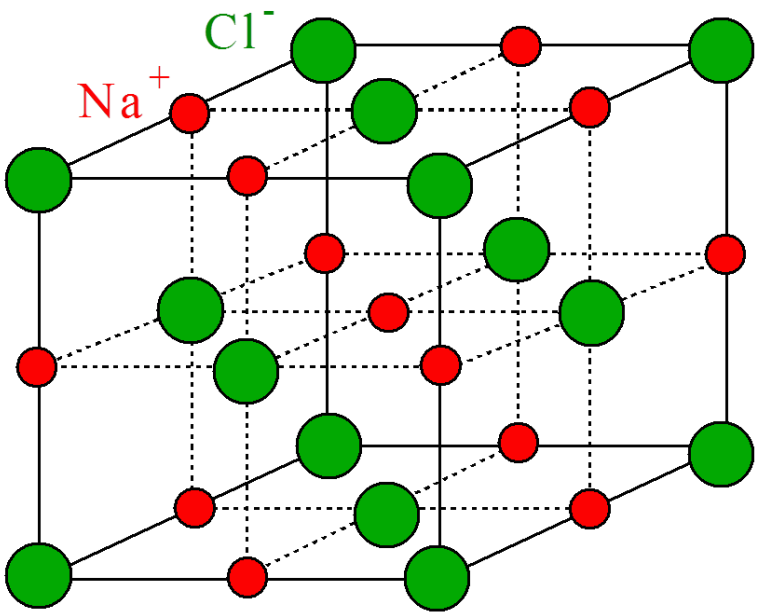
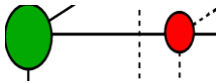
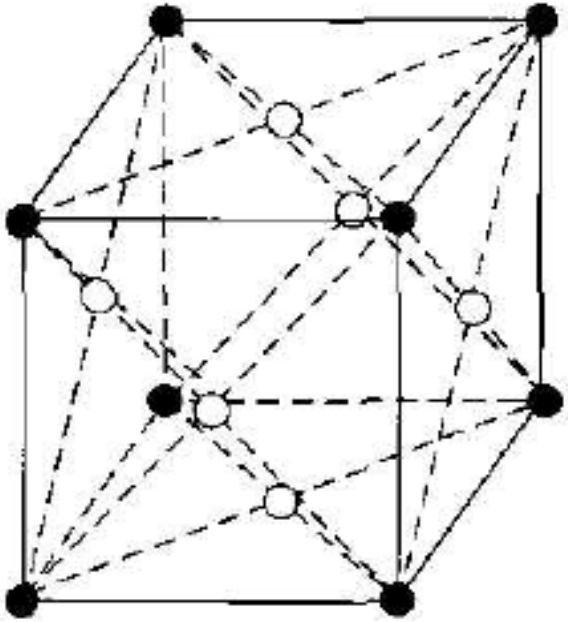
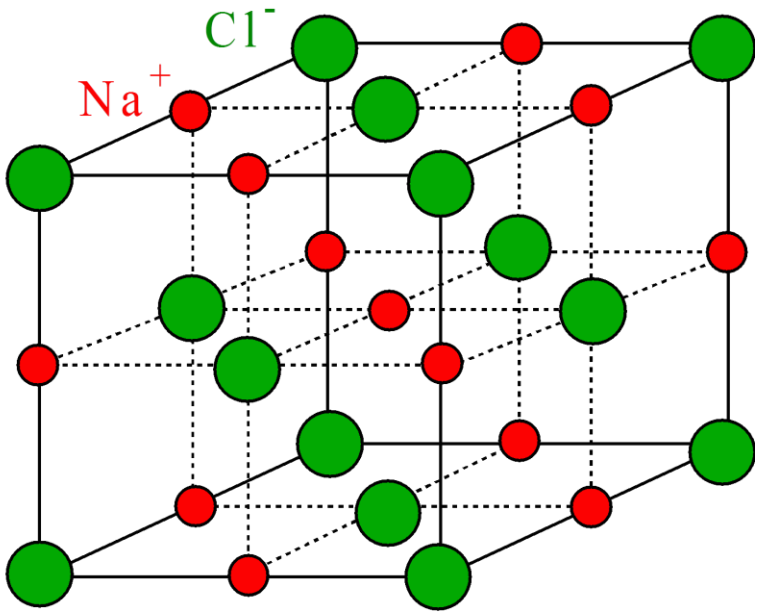


Fig. 1.36: A possible reduced sphere unit cell for the NaCl (rock salt) crystal. An alternative unit cell may have Na^+ and Cl^- interchanged. Examples: AgCl, CaO, CsF, LiF, LiCl, NaF, NaCl, KF, KCl, MgO







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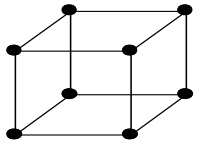
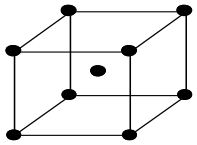
UNIT CELL GEOMETRY

CUBIC SYSTEM
$a = b = c \quad \alpha = \beta = \gamma = 90°$

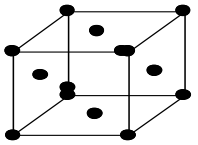
Many metals, Al, Cu, Fe, Pb. Many ceramics and semiconductors, NaCl, CsCl, LiF, Si, GaAs



Simple cubic



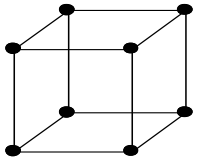
Body centered cubic



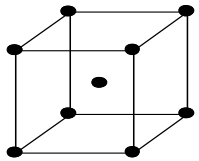
Face centered cubic

TETRAGONAL SYSTEM
$a = b - c \quad \alpha = \beta = \gamma = 90°$

In, Sn, Barium Titanate, TiO_2



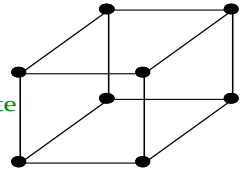
Simple tetragonal



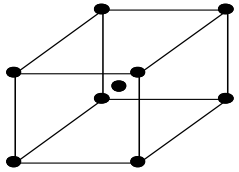
Body centered tetragonal

ORTHORHOMBIC SYSTEM
$a - b - c \quad \alpha = \beta = \gamma = 90°$

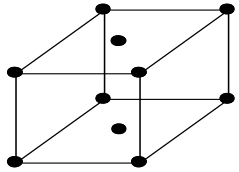
S, U, Pl, Ga (<30°C), Iodine, Cementite (Fe_3C), Sodium Sulfate



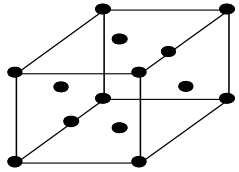
Simple orthorhombic



Body centered orthorhombic



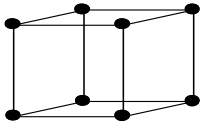
Base centered orthorhombic



Face centered orthorhombic

HEXAGONAL SYSTEM
$a = b - c \quad \alpha = \beta = 90° ; \gamma = 120°$

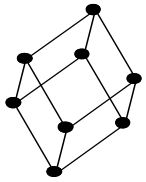
Cadmium, Magnesium, Zinc, Graphite



Hexagonal

RHOMBOHEDRAL SYSTEM
$a = b = c \quad \alpha = \beta = \gamma - 90°$

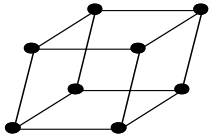
Arsenic, Boron, Bismuth, Antimony, Mercury (<-39°C)



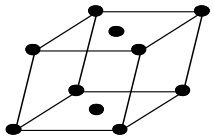
Rhombohedral

MONOCLINIC SYSTEM
$a - b - c \quad \alpha = \beta = 90° ; \gamma - 90°$

α–Selenium, Phosphorus
Lithium Sulfate
Tin Fluoride



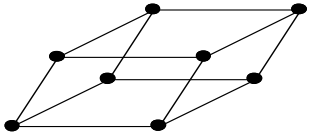
Simple monoclinic



Base centered monoclinic

TRICLINIC SYSTEM
$a - b - c \quad \alpha - \beta - \gamma - 90°$

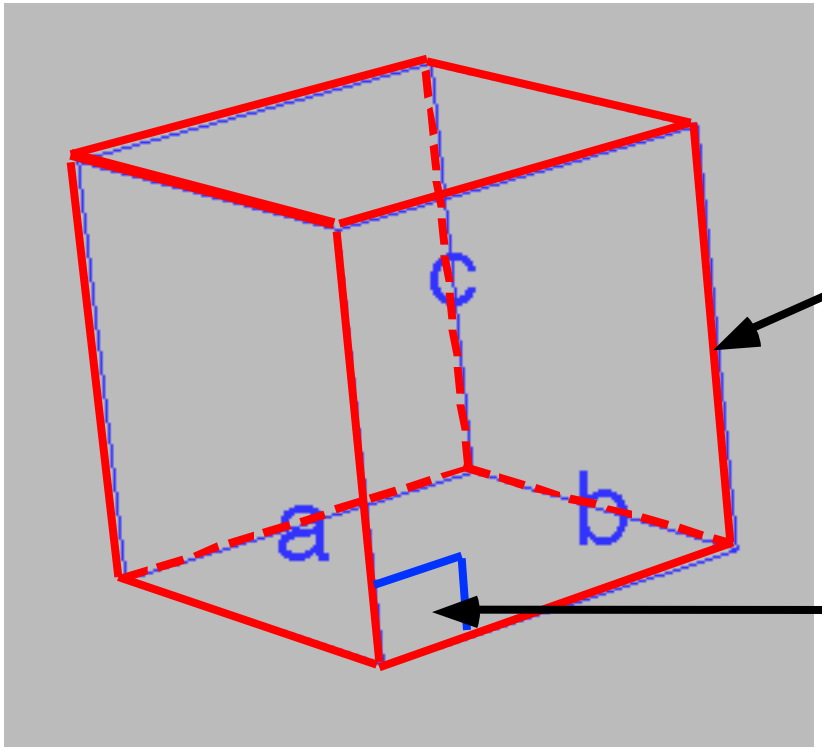
Potassium dicromate



Triclinic

Fig. 1.71: The seven crystal systems (unit cell geometries) and fourteen Bravais lattices.

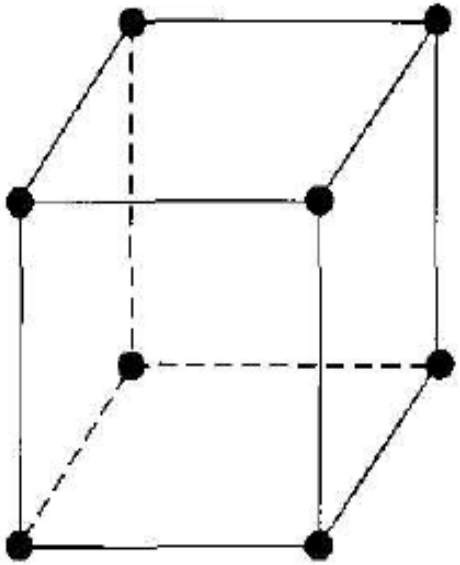
Cubic Unit Cells



All sides
equal length

All angles
are 90 degrees

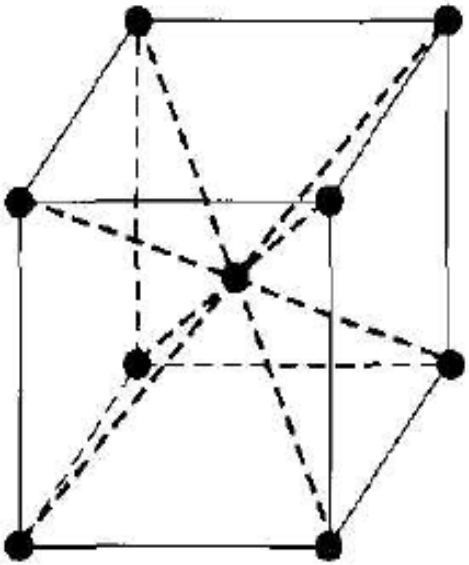
Simple Cubic



SC

n=

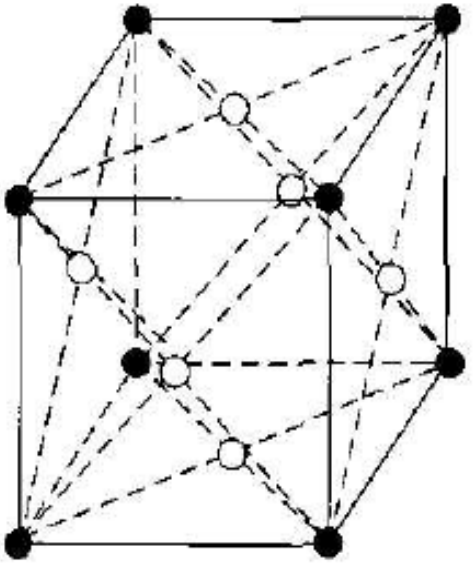
Body Centered Cubic



BCC

n=

Face Centered Cubic

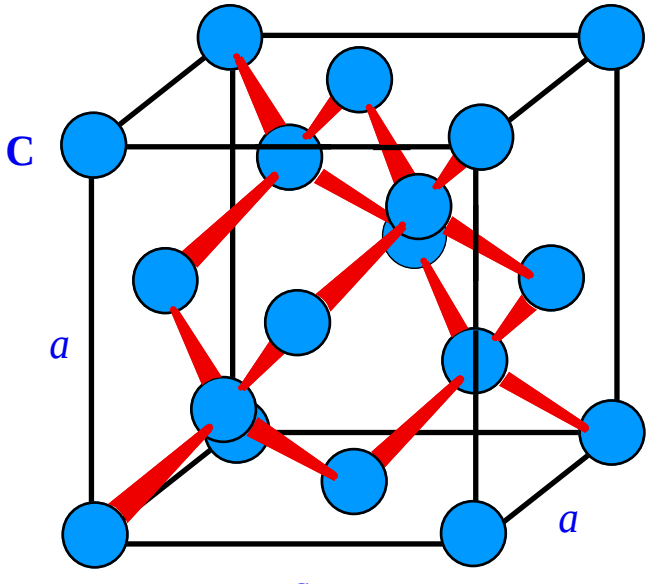


FCC

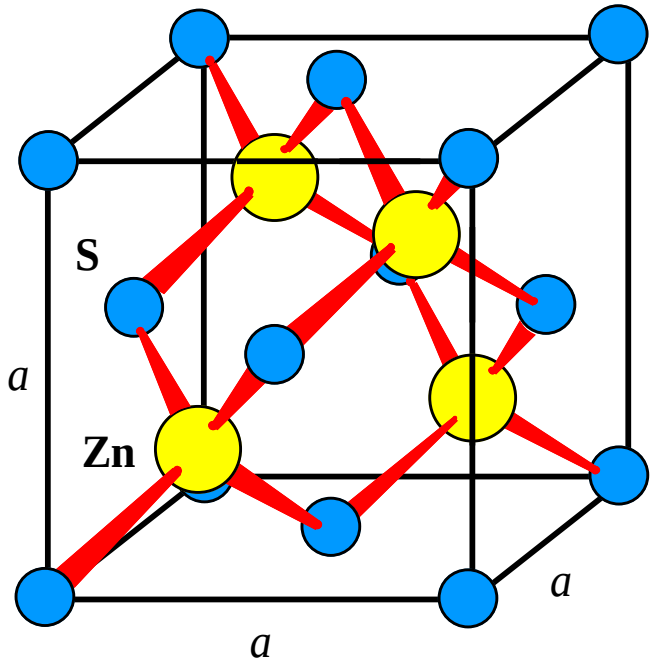
n=

Diamond

(two interpenetrating Fcc lattices)

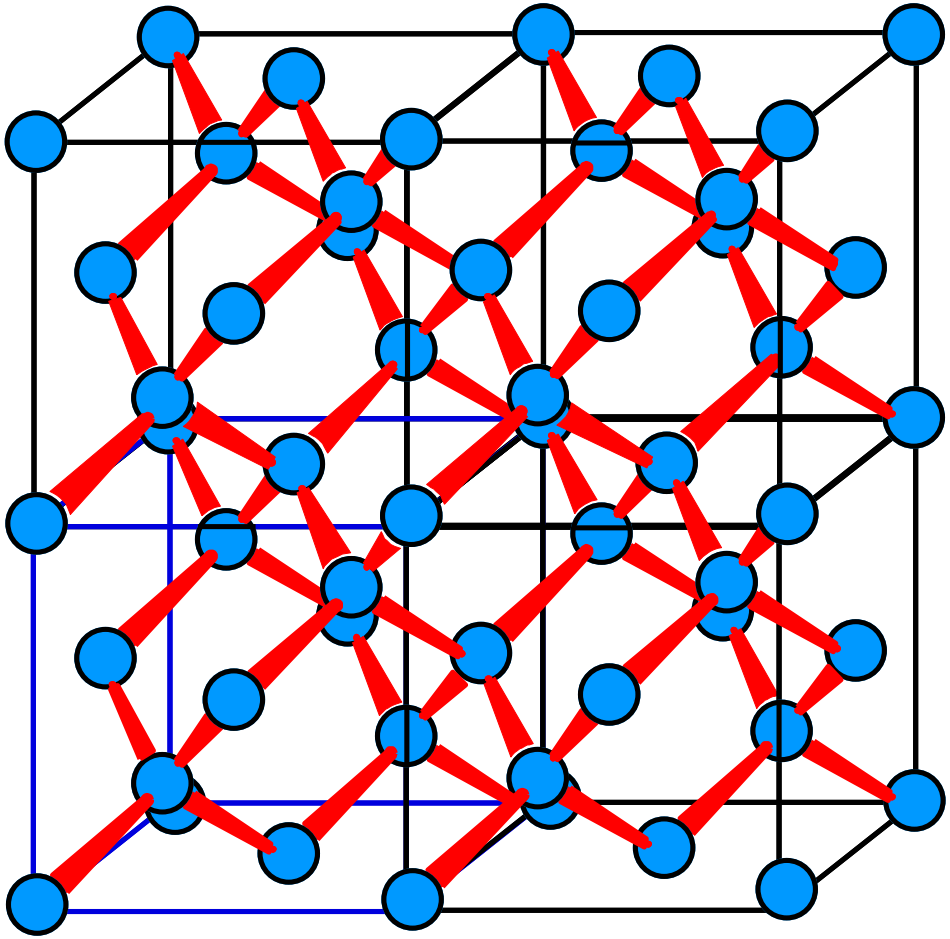


n=



Zinc Blende

$n_1=$, $n_2 =$



The diamond crystal is a covalently bonded network of carbon atoms. Each carbon atom is bonded covalently to four neighbors forming a regular three dimensional pattern of atoms which constitutes the diamond crystal.

Fig 1.6

Packing

$$\text{Atomic Packing Factor}: \frac{\text{Volume of atoms in unit cell}}{\text{Volume of unit cell}}$$

$$APF = \frac{n * \frac{4}{3}\pi R^3}{a^3}$$

Mass density:

$$\rho = \frac{n*(M / N_A)}{a^3}$$