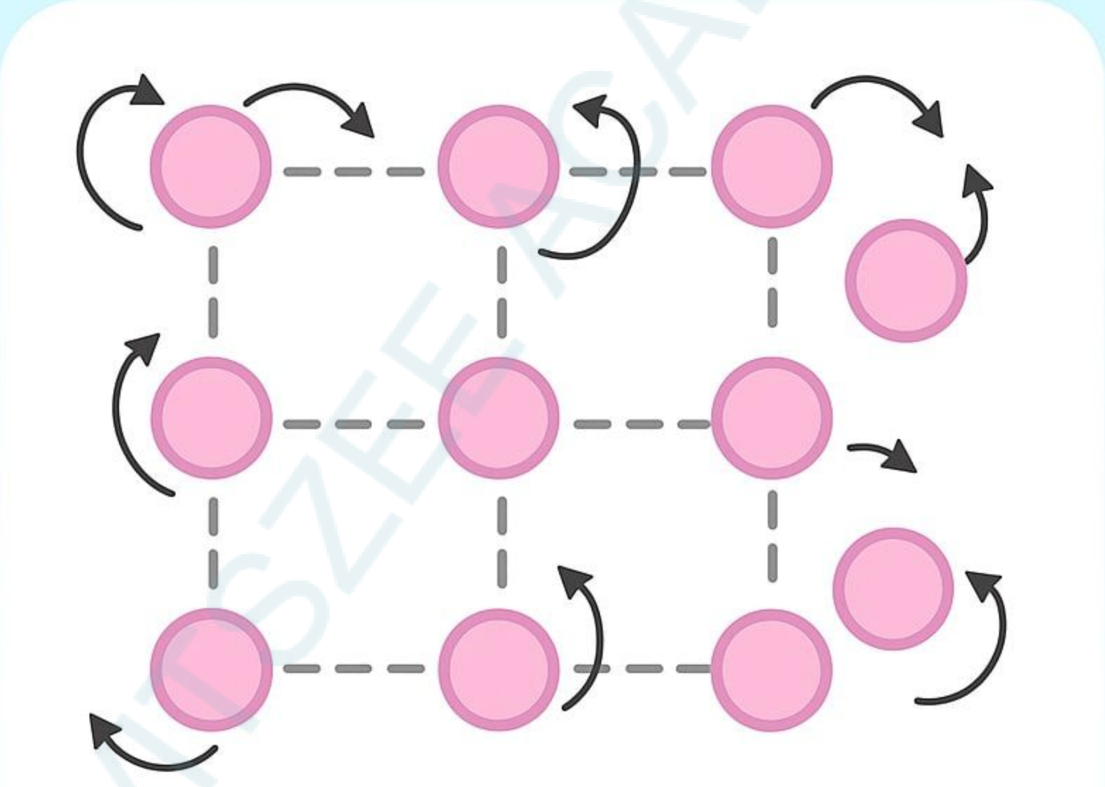
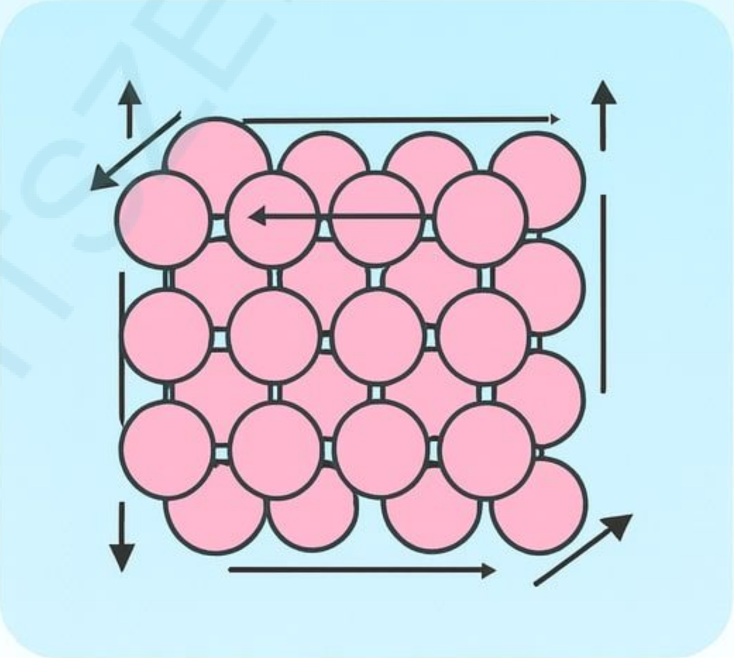
1.1. Why are solids rigid?

Ans: The constituent particles in solids have fixed positions and move about their mean positions. Hence, they are rigid.



1.2. Why do solids have definite volume?

Ans: Solids keep their volume because of rigidity in their structure. The interparticle forces are very strong. Moreover, their interparticle spaces are very few and small as well. As a result, their volumes cannot change by applying pressure.



1.3. Classify the following as amorphous or crystalline solids: Polyurethane, naphthalene, benzoic acid, Teflon, potassium nitrate, cellophane, polyvinyl chloride, fibreglass, copper

Ans: Crystalline solids: Benzoic acid, potassium nitrate, copper Amorphous solids: Polyurethane, polyvinyl chloride, fibreglass

1.4. Why is glass considered as super cooled liquid ? (C.B.S.E. Delhi 2013)

Ans: Glass is considered to be super cooled liquid because it shows some of the characteristics of liquids, though it is an amorphous solid. For example, it is slightly thicker at the bottom. This can be possible only if it has flown like liquid, though very slowly.

1.5. Refractive index of a solid is observed to have the same value along all directions. Comment on the nature of this solid. Would it show cleavage property?

Ans: As the solid has same value of refractive index along all directions, it is isotropic in nature and hence amorphous. Being amorphous solid, it will not show a clean cleavage and when cut, it will break into pieces with irregular surfaces.

1.6. Classify the following solids in different categories based on the nature of the intermolecular forces: sodium sulphate, copper, benzene, urea, ammonia, water, zinc sulphide, diamond, rubedium, argon, silicon carbide.

Ans: Ionic, metallic, molecular, molecular, molecular (hydrogen-bonded), molecular (hydrogen-bonded), ionic, covalent, metallic, molecular, covalent (network).

1.7. Solid A is a very hard electrical insulator in solid as well as in molten state and melts at extremely high temperature.

Ans: It is a covalent or network solid.

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1.8. Why are ionic solids conducting in the molten state and not in the solid-state?

Ans: In the ionic solids, the electrical conductivity is due to the movement of the ions. Since the ionic mobility is negligible in the solid state, these are non-conducting in this state. Upon melting, the ions present acquire some mobility. Therefore, the ionic solids become conducting.

1.9. What type of solids are electrical conductors, malleable and ductile?

Ans: Metallic solids.

1.10. Give the significance of a lattice point.

Ans: The lattice point denotes the position of a particular constituent in the crystal lattice. It may be atom, ion or a molecule. The arrangement of the lattice points in space is responsible for the shape of a particular crystalline solid.

1.11. Name the parameters that characterise a unit cell.

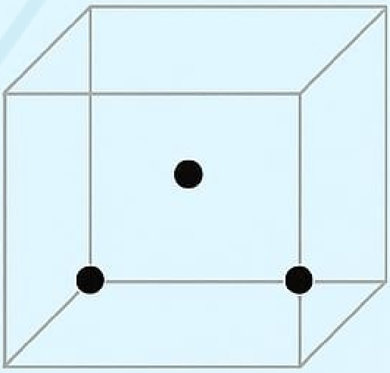
Ans: A unit cell is characterised by the following parameters:
(i) the dimensions of unit cell along three edges: a, b and c.
(ii) the angles between the edges: α (between b and c); β (between a and c) and γ (between a and b).

1.12. Distinguish between:

(i) Hexagonal and monoclinic unit cells

(ii) Face-centred and end-centred unit cells

Ans:



Face centred unit cell

(i) In a **hexagonal unit cell:**

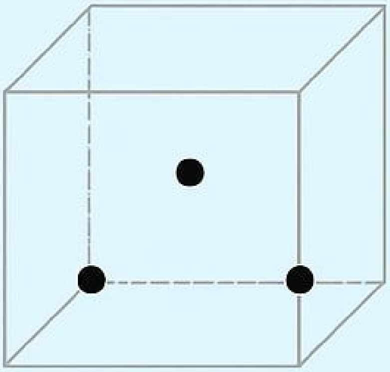
$a = b \neq c$, $\alpha = \beta = 90°$ and $\gamma = 120°$

In a **monoclinic** unit cell:

$a \neq \beta \neq c$ and $\alpha = \gamma = 90°$ and $\beta \neq 90°$

(ii) In a **face-centred** unit cell, constituent particles are located at all the corners as well as at the centres of two opposite faces.

In **end-centred** unit cell, constituent particles are located at all the corners as well as at the centres of two opposite faces.



End centred unit cell

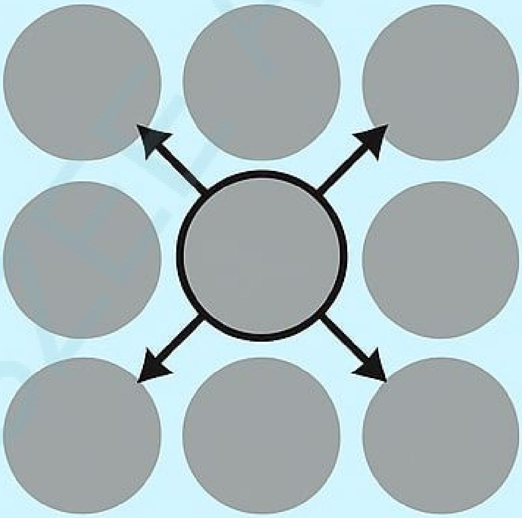
1.13. Explain how many portions of an atom located at (i) corner and (ií) body centre of a cubic unit cell is part of its neighbouring unit cell.

Ans: (i) An atom at the corner is shared by eight adjacent unit cells. Hence, portion of the atom at the corner that belongs to one unit cell = 1/8.

(ii) An atom at the body centre is not shared by any other unit cell. Hence, it belongs fully to unit cell.

1.14. What is the two-dimensional coordination number of a molecule in a square close-packed layer?

Ans: In the two-dimensional square close-pack-layer, a particular molecule is in contact with four molecules. Hence, the coordination number of the molecule is four.



1.15. A compound forms hexagonal close-packed structure. What is the total number of voids in 0.5 mol of it? How many these are tetrahedral voids?

Ans:

No. of atoms in close packing 0,5 mol = $0,5 \times 6,022 \times 10^{23} = 3,011 \times 10^{23}$

No. of octahedral voids = No. of atoms in packing $= 3,011 \times 10^{23}$

No. of tetrahedral voids = 2 × No. of atoms in packing $= 2 \times 3,011 \times 10^{23} = 6,022 \times 10^{23}$

Total no. of voids $= 3,011 \times 10^{23} + 6,022 \times 10^{23} = 9,033 \times 10^{23}$

1.16. A compound is formed by two elements M and N. The element N forms ccp and atoms of the element M occupy 1/3 of the tetrahedral voids. What is the formula of the compound? (C.B.S.E. Foreign 2015)

Ans: Let us suppose that,

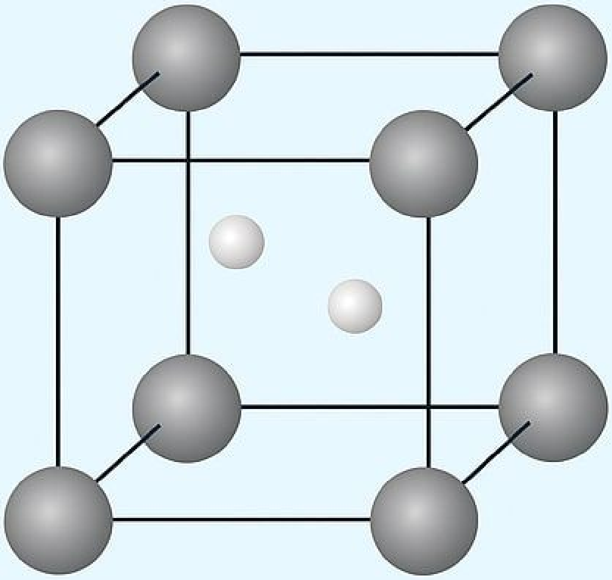
the no. of atoms of N present in ccp = x

Since 1/3 of the tetrahedral voids are occuppied by atoms of M, therefore,

Ratio of atoms of N : M =

x : 2x/3 = 3 : 2

∴ The formula of the compound = N_3M_2 or M_2N_3



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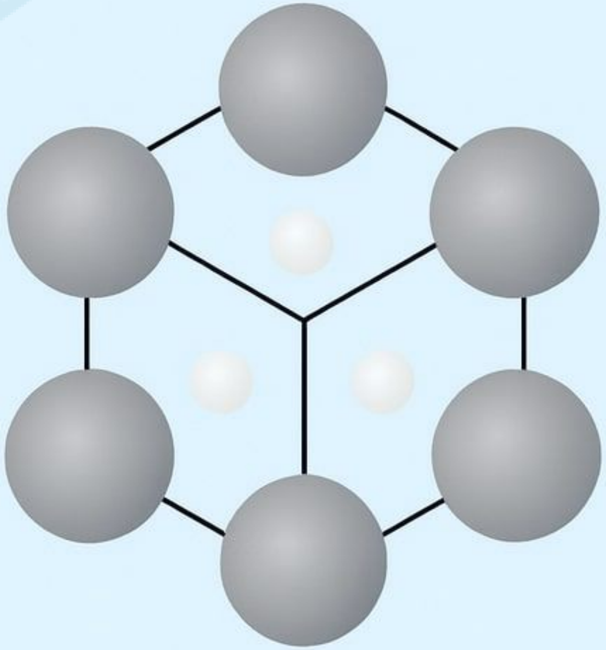
1.17. Which of following lattices has the highest packing efficiency (i) simple cubic (ii) body-centered cubic and (iii) hexagonal close-packed lattice?

Ans: Packing efficiency of:

Simple cubic = 52.4% bcc = 68%

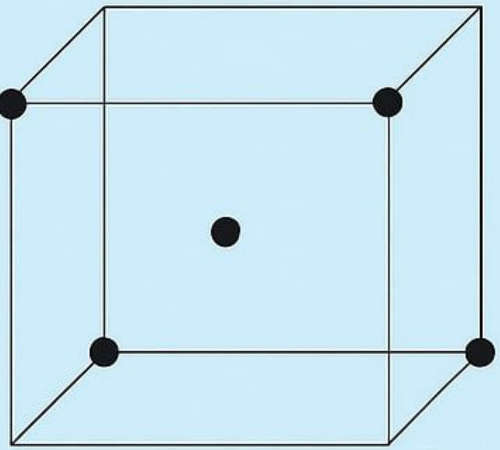
hcp lattice has the highest packing efficiency.



1.18. An element with molar mass 2.7×10^2 kg mol^{-1} forms a cubic unit cell with edge length 405 pm. If its density is 2.7 Delhi 10 (B.S.S.E. Delhi 2015)

Ans:

We know that, $\rho = \frac{Z\times M}{a^3\times N_0\times^{-30}}$ or $Z = \rho\,\frac{\rho a^3\times N_0}{M}$



Edge length of unit cell (a) = 405 pm = 405×10^{-12} m =

Molar mass of unit cell (M) = 2.7×10^2 kg mol^{-1}

Density of the unit cell (ρ) = 2.7×10^3 kg m^{-3}

Avogadro's No. (N_0) = 6.022×10^{23} mol^{-1}

$$Z = \frac{(2.7\times10^3\text{ kg m}^{-3})\times(4.05\times10^{-10}\text{m})(6.022\times10^{23})}{(2.7\times10^2\text{ kg mol}^{-1})} = \mathbf{3.99}$$

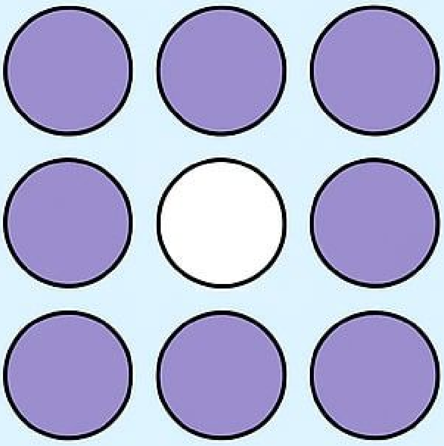
4

Since there are four atoms per unit cell, the cubic unit cell must be crantred (fcc) or cubic close packed (ccp).

1.19. What type of defect can arise when a solid is heated? Which physical property is affected by it and in what way?

Ans: When a solid is heated, vacancy defect is produced in the crystal.

On heating, some atoms or ions leave the lattice site completely, i.e., lattice sites become vacant. As a result of this defect, density of the substance decreases.



Vacancy defect

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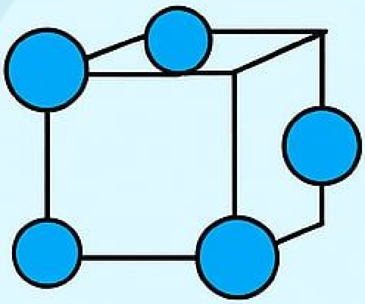
1.20. What types of stoichiometric defects are shown by (C.B.S.E. Delhi 2013)

Ans:

(i) ZnS crystals may show Frenkel defects since the cationic size is smaller as compared to anionic size.

(ii) AgBr crystals may show both Frenkel and Schottky defects.



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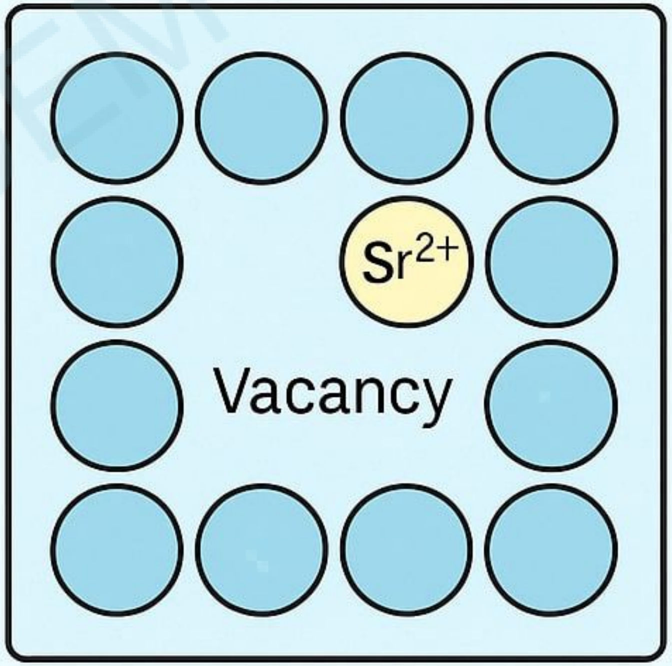
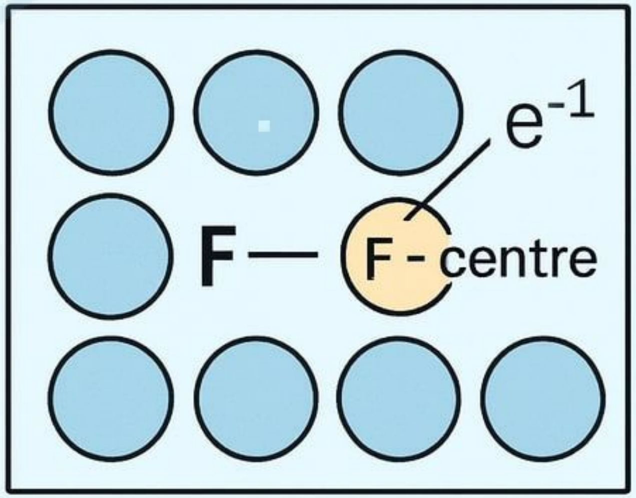
1.21. Explain how vacancies are introduced in an ionic solid when a cation of higher valence is added as an impurity in it.

Ans:



Let us take an example NaCl doped with SrCl. When $SrCl_2$ is added to NaCl solid as an impurity, two Na^+ ions will be replaced and one of their sites will be occupied by Sr^{2+} while the other will remain vacant. Thus, when a cation of higher valency is added as an impurity to an ionic solid, two or more cations of lower valency are replaced by one cation of higher valency to maintain electrical neutrality. Hence, some cationic vacancies are created.

1.22. Ionic solids, which have anionic vacancies due to metal excess defect, develop colour. Explain with help of a suitable example.



Ans: Let us take an example O NaCl. When NaCl crystal is heated in presence of Na vapour, some Cl^- ions leave lattice sites to combine with Na to form NaCl. Na^+ + $Cl^{-\,-}$) diffuse into the crystal to occupy the anion vacancies. These sites are called F-centres. These e^- absorb eits from visible light, get excited to higher energy level and when they fall back to ground state crysstal.

1.23. A group 14 element is to be converted into n-type semiconductor by doping it with a suitable impurity. To which group should this impurity belong?

Ans: Impurity from group 15 should be added to get n-type semiconductor.

1.24. What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic. Justify your answer.

Ans: Ferromagnetic substances make better permanent magnets. This is because when placed in magnetic field, their domains get oriented in the directions of magnetic field and a strong magnetic field is produced. This ordering of domains persists even when external magnetic field is removed. Hence, the ferromagnetic substance becomes a permanent magnet.