

Chemistry

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(Chapter 1)(The Solid State)
(Class 12)

Answer 1.24:

(i) For cubic close-packed structure:

$$a = 2\sqrt{2}r = 2\sqrt{2} \times 125 \text{ pm} = 353.55 \text{ pm} = 354 \text{ pm (approximately)}$$

$$(ii) \text{ Volume of one unit cell} = (354 \text{ pm})^3 \\ = 4.4 \times 10^7 \text{ pm}^3 = 4.4 \times 10^7 \times 10^{-30} \text{ cm}^3 = 4.4 \times 10^{-23} \text{ cm}^3$$

$$\text{Therefore, number of unit cells in } 1.00 \text{ cm}^3 = \frac{1.00 \text{ cm}^3}{4.4 \times 10^{-23} \text{ cm}^3} = 2.27 \times 10^{22}$$

Question 1.25:

If NaCl is doped with 10^{-3} mol % of SrCl_2 , what is the concentration of cation vacancies?

Answer 1.25:

It is given that NaCl is doped with 10^{-3} mol% of SrCl_2 .

This means that 100 mol of NaCl is doped with 10^{-3} mol of SrCl_2 .

Therefore, 1 mol of NaCl is doped with $\frac{10^{-3}}{100}$ mol of $\text{SrCl}_2 = 10^{-5}$ mol of SrCl_2

Cation vacancies produced by one Sr^{2+} ion = 1

∴ Concentration of the cation vacancies

$$\begin{aligned} \text{produced by } 10^{-5} \text{ mol of } \text{Sr}^{2+} \text{ ions} &= 10^{-5} \times 6.022 \times 10^{23} \\ &= 6.022 \times 10^{18} \text{ mol}^{-1} \end{aligned}$$

Hence, the concentration of cation vacancies created by SrCl_2 is 6.022×10^{18} per mol of NaCl.

Question 1.26:

Explain the following with suitable examples:

- (i) Ferromagnetism
- (ii) Paramagnetism
- (iii) Ferrimagnetism
- (iv) Antiferromagnetism
- (v) 12-16 and 13-15 group compounds.

Answer 1.26:

(i) **Ferromagnetism:** The substances that are strongly attracted by a magnetic field are called ferromagnetic substances. Ferromagnetic substances can be permanently magnetised even in the absence of a magnetic field. Some examples of ferromagnetic substances are iron, cobalt, nickel, gadolinium, and CrO_2 .

In solid state, the metal ions of ferromagnetic substances are grouped together into small regions called domains and each domain acts as a tiny magnet. In an unmagnetised piece of a ferromagnetic substance, the domains are randomly-oriented and so, their magnetic moments get cancelled. However, when the substance is placed in a magnetic field, all the domains get oriented in the direction of the magnetic field. As a result, a strong magnetic effect is produced. This ordering of domains persists even after the removal of the magnetic field. Thus, the ferromagnetic substance becomes a permanent magnet.



Schematic alignment of magnetic moments in ferromagnetic substances

(ii) **Paramagnetism:** The substances that are attracted by a magnetic field are called paramagnetic substances. Some examples of paramagnetic substances are O_2 , Cu^{2+} , Fe^{3+} , and Cr^{3+} .

Paramagnetic substances get magnetised in a magnetic field in the same direction, but lose magnetism when the magnetic field is removed. To undergo paramagnetism, a substance must have one or more unpaired electrons. This is because the unpaired electrons are attracted by a magnetic field, thereby causing paramagnetism.

(iii) **Ferrimagnetism:** The substances in which the magnetic moments of the domains are aligned in parallel and anti-parallel directions, in unequal numbers, are said to have ferrimagnetism. Examples include Fe_3O_4 (magnetite), ferrites such as MgFe_2O_4 and ZnFe_2O_4 .

Ferrimagnetic substances are weakly attracted by a magnetic field as compared to ferromagnetic substances. On heating, these substances become paramagnetic.



Schematic alignment of magnetic moments in ferrimagnetic substances

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Lei Huang



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