Nishant Jindal

SOLID STATE

$1 - 1$

$8 - 2^3$

$27 - 3^3$

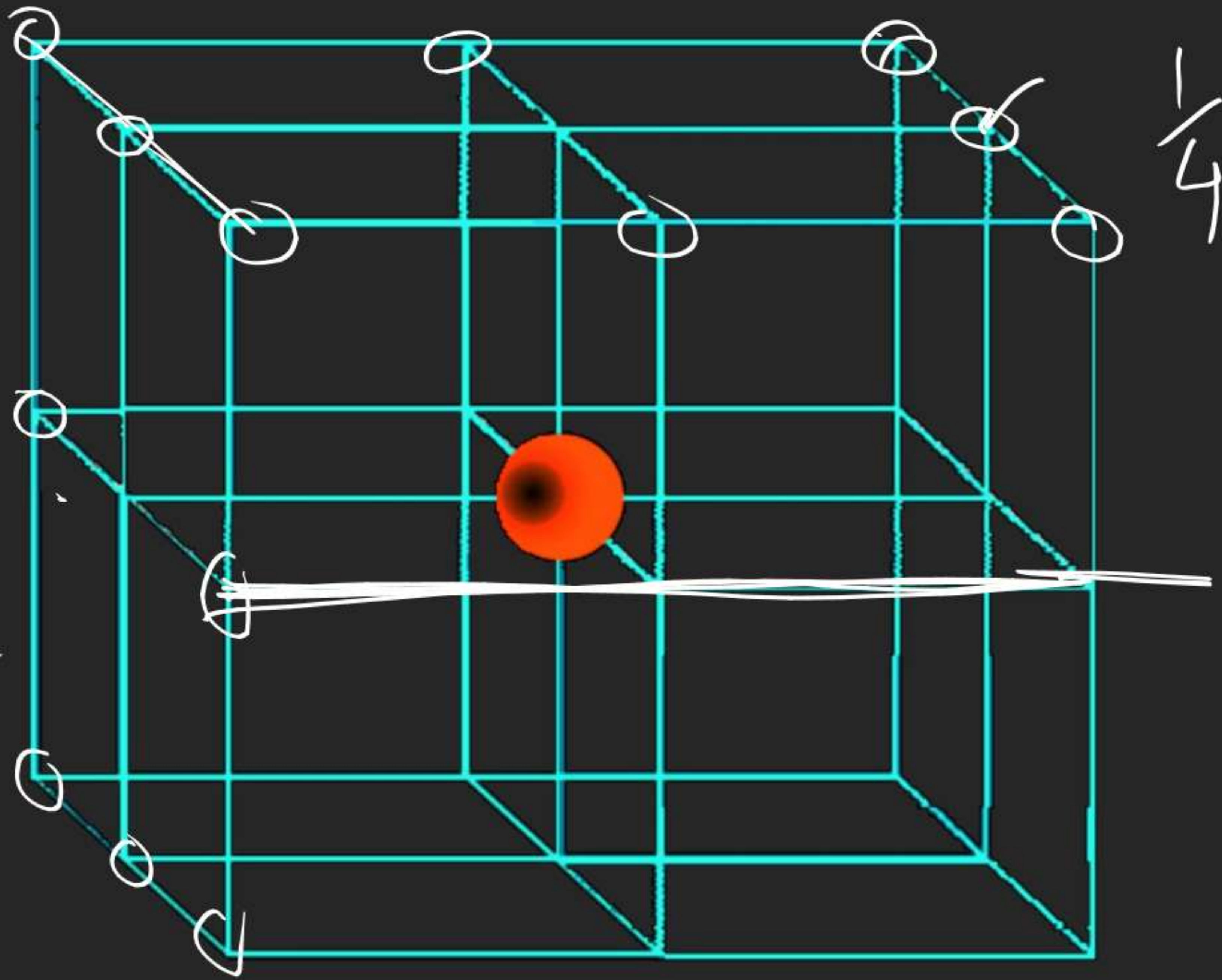
$64 - 4^3$

FCC

HCP

x^3

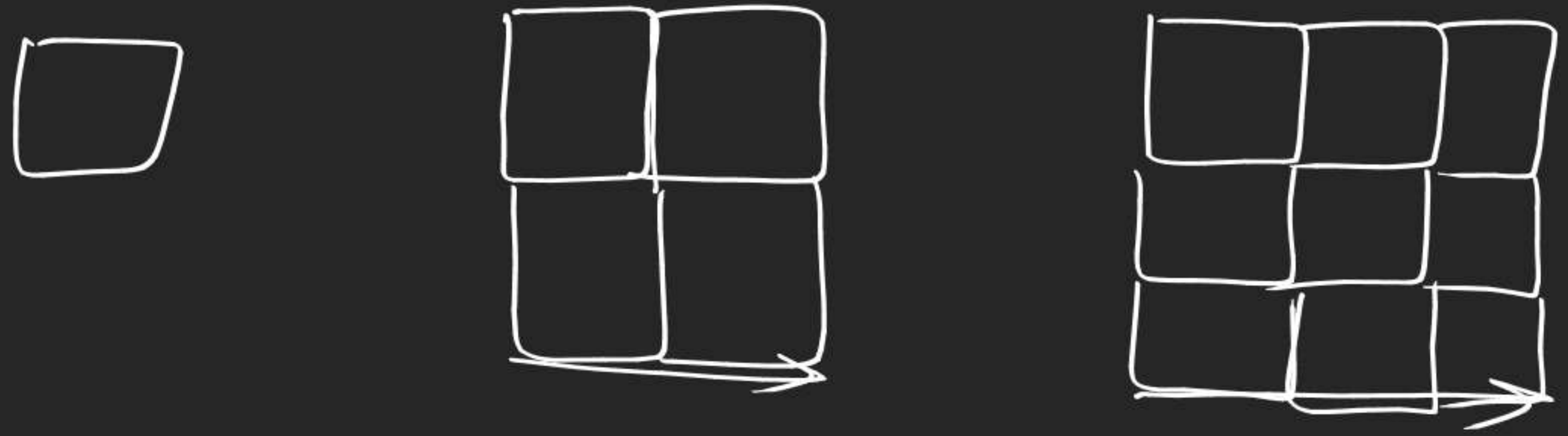
$a = 4r$



$\frac{1}{8} \times 8 = 1$

$\frac{1}{4} \times 12 = 3$

$\overline{4}$



$1 \qquad 2^2 \qquad 3^2 \qquad 4^2$

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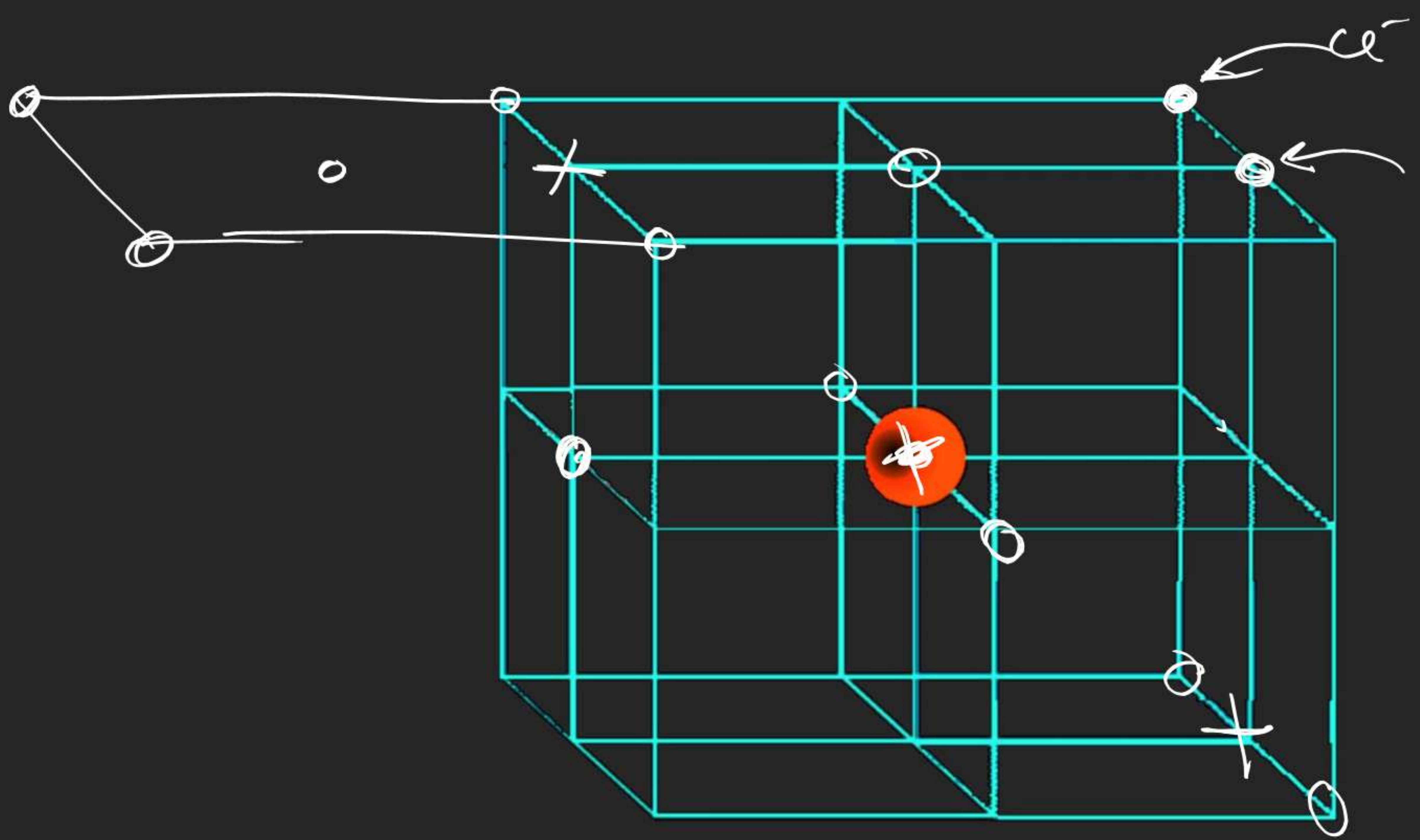

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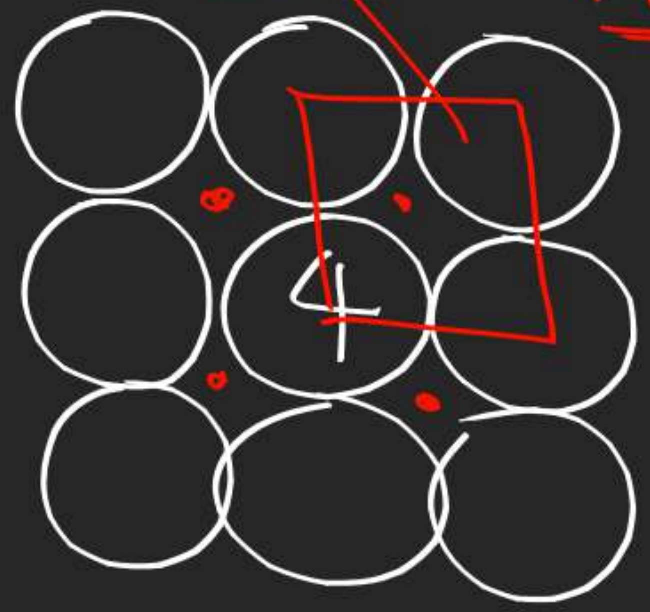
$$d = \frac{Z \times M_{CaF_2}/N_A}{a^3}$$

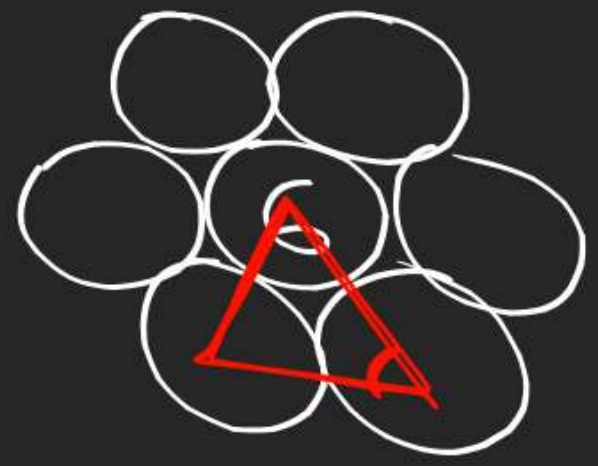
5

1 atom

1 void



per atom 2 voids



$= \frac{1}{6} \times 3$

1 void

$= \frac{1}{2}$ atom

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$Cl^- \longrightarrow FCC$

$Na^+ \longrightarrow OV$

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(2)

A	B
FCC	O.V
4	4

4 Corner

2 Face centre

$$4 \times \frac{1}{8} + 2 \times \frac{1}{2}$$

$$= \frac{1}{2} + 1$$

$$= \underline{1.5}$$

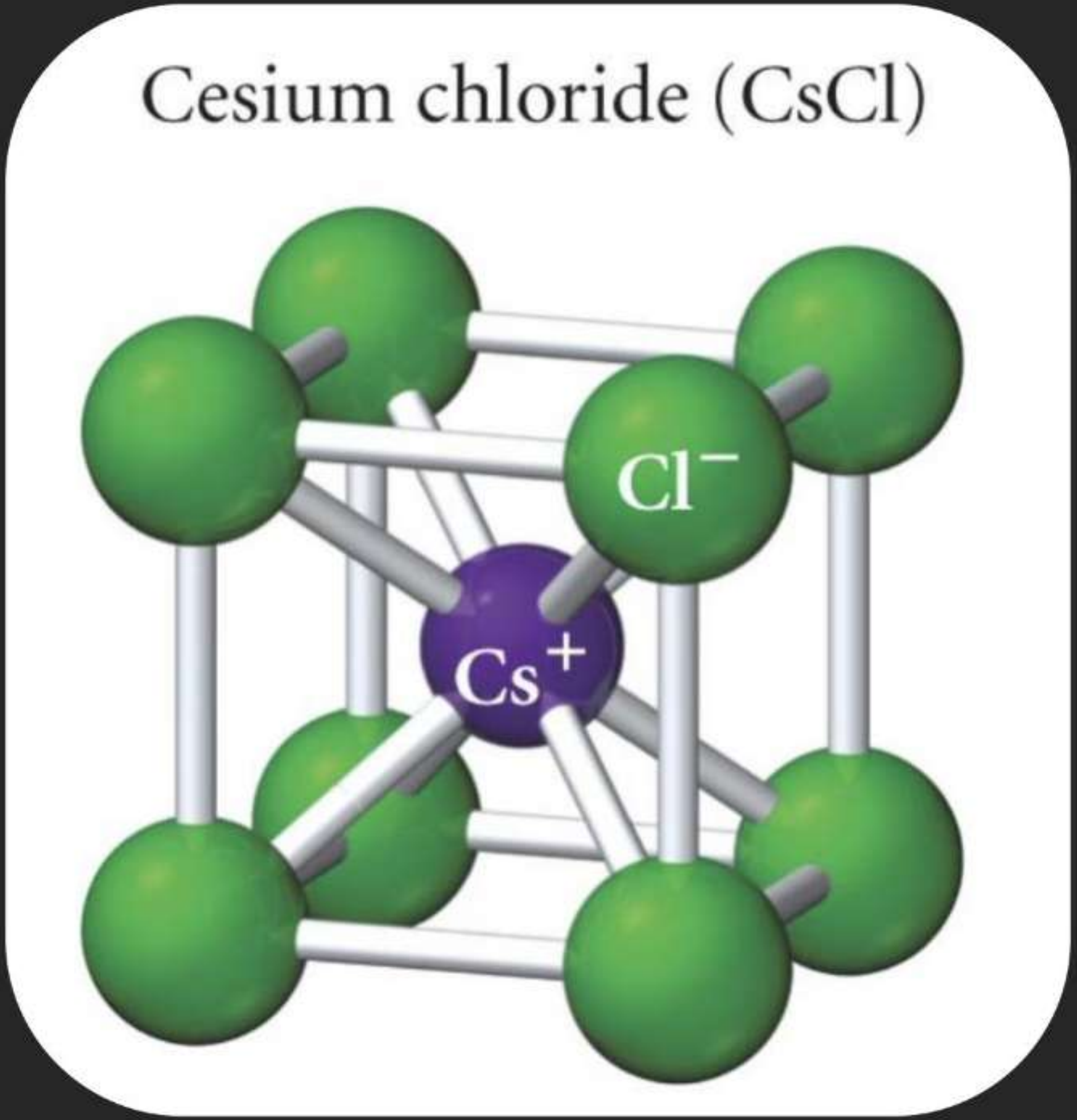
B — cube centre = 1

2 edge cent

$$2 \times \frac{1}{4} = \frac{1}{2}$$

$$= \underline{1.5}$$

SOLID STATE



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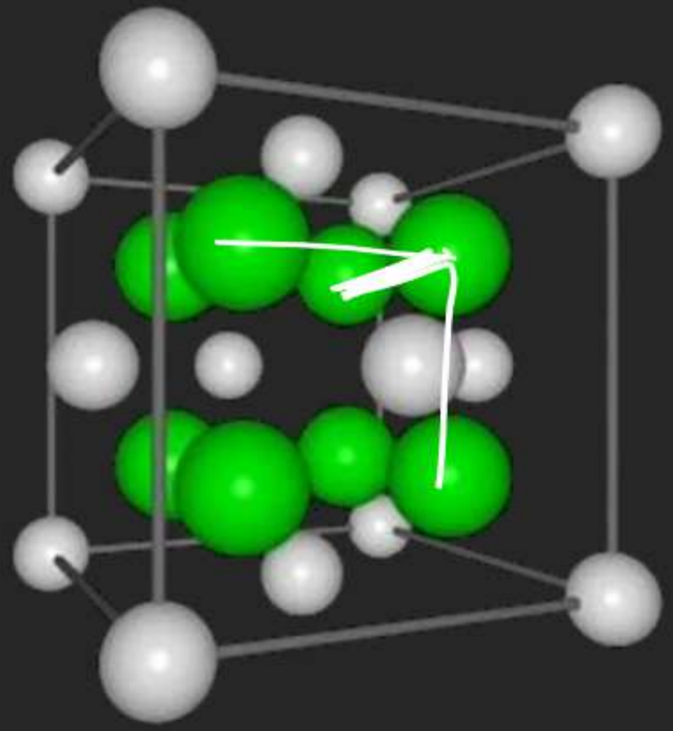
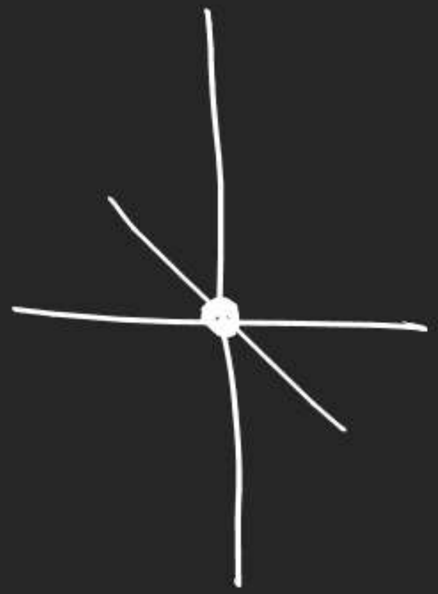
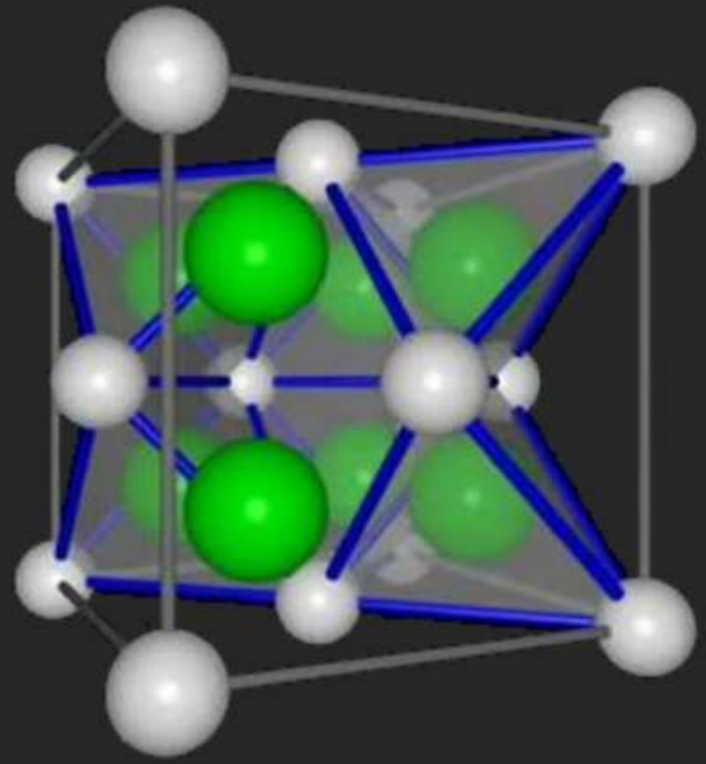




Fluoride Ions Occuy Tetrahedral Holes



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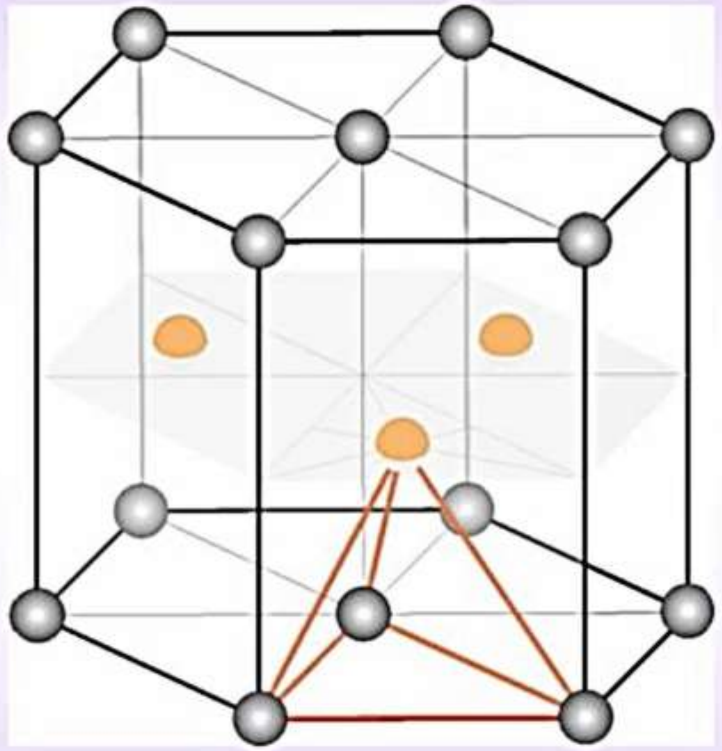
SOLID STATE

HCP

VOIDS

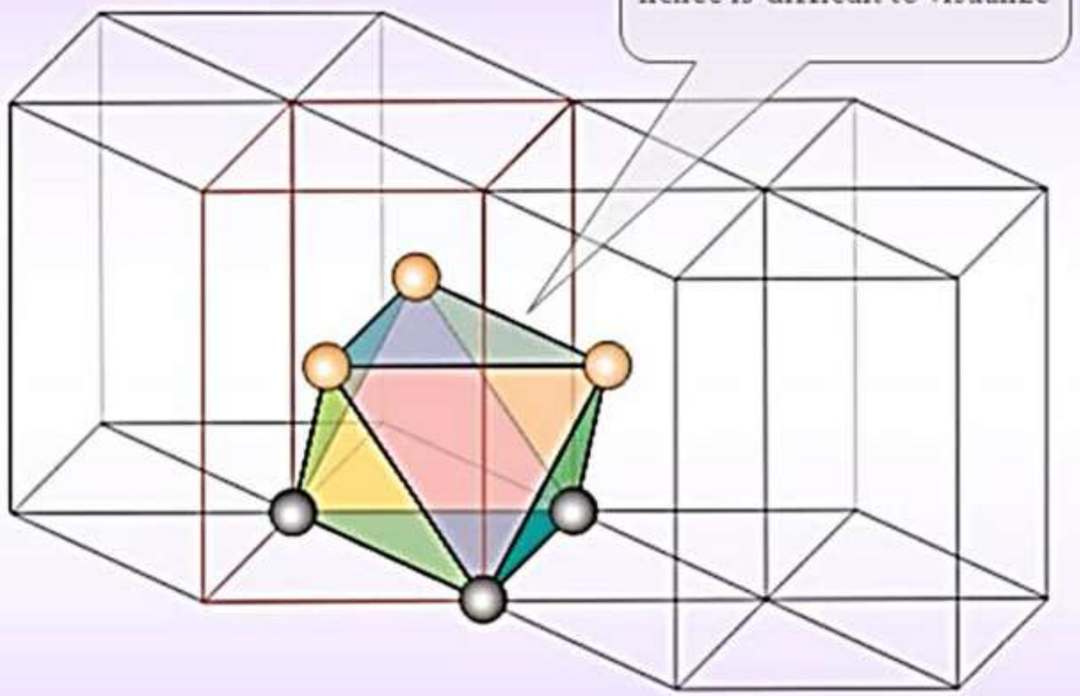
TETRAHEDRAL



Coordinates : $(0,0,\frac{3}{8}),(0,0,\frac{5}{8}),(\frac{2}{3},\frac{1}{3},\frac{1}{8}),(\frac{2}{3},\frac{1}{3},\frac{7}{8})$

OCTAHEDRAL

This void extends across 3 conventional unit cells and hence is difficult to visualize



Coordinates: $(\frac{1}{3}\ \frac{2}{3},\frac{1}{4}),\ (\frac{1}{3},\frac{2}{3},\frac{3}{4})$

- These voids are identical to the ones found in FCC *(for ideal c/a ratio)*.
- When the c/a ratio is non-ideal then the octahedra and tetrahedra are distorted *(non-regular)*.

Important Note: often in these discussions an ideal c/a ratio will be assumed (without stating the same explicitly).

If c/a ratio is not the ideal one – then the voids will not be 'regular' (i.e. regular octahedron and regular tetrahedron).

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O-I

35

8 : 8

CsCl type

$$\frac{\sqrt{3}a}{2} = r_+ + r_-$$

NaCl

6 : 6

ZnS

4 : 4

38

$$\frac{r_+}{r_-} = 0.225$$

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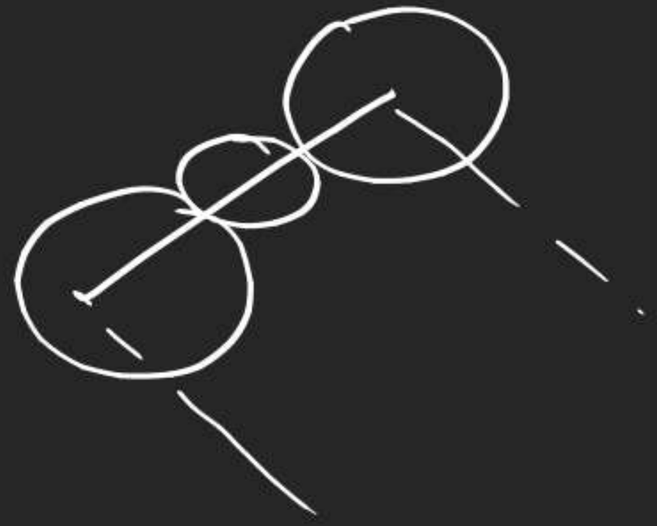
S-I 28

$$a = 2r_-$$

$$a = 2 \times 2.17\ A^\circ$$



27

$$\sqrt{3}a = 2r_+ + 2r_-$$

$$= 7\ A^\circ$$

26

$$\frac{\sqrt{3}a}{2} = r_+ + r_- = \underline{200\sqrt{3}\ \text{Ans}}$$

$$\text{height} = 2r$$

$$\text{length} = 4r$$

$$\text{Area} = (4r)^2$$

$$\text{Volume} = 32r^3$$

$$PF = \frac{4 \times \frac{4}{3}\pi \cancel{r^3}}{32 \cancel{r^3}} \times 100 = \frac{\pi}{6} \times 100$$

$$= 100 - \frac{\pi}{6} \times 100$$

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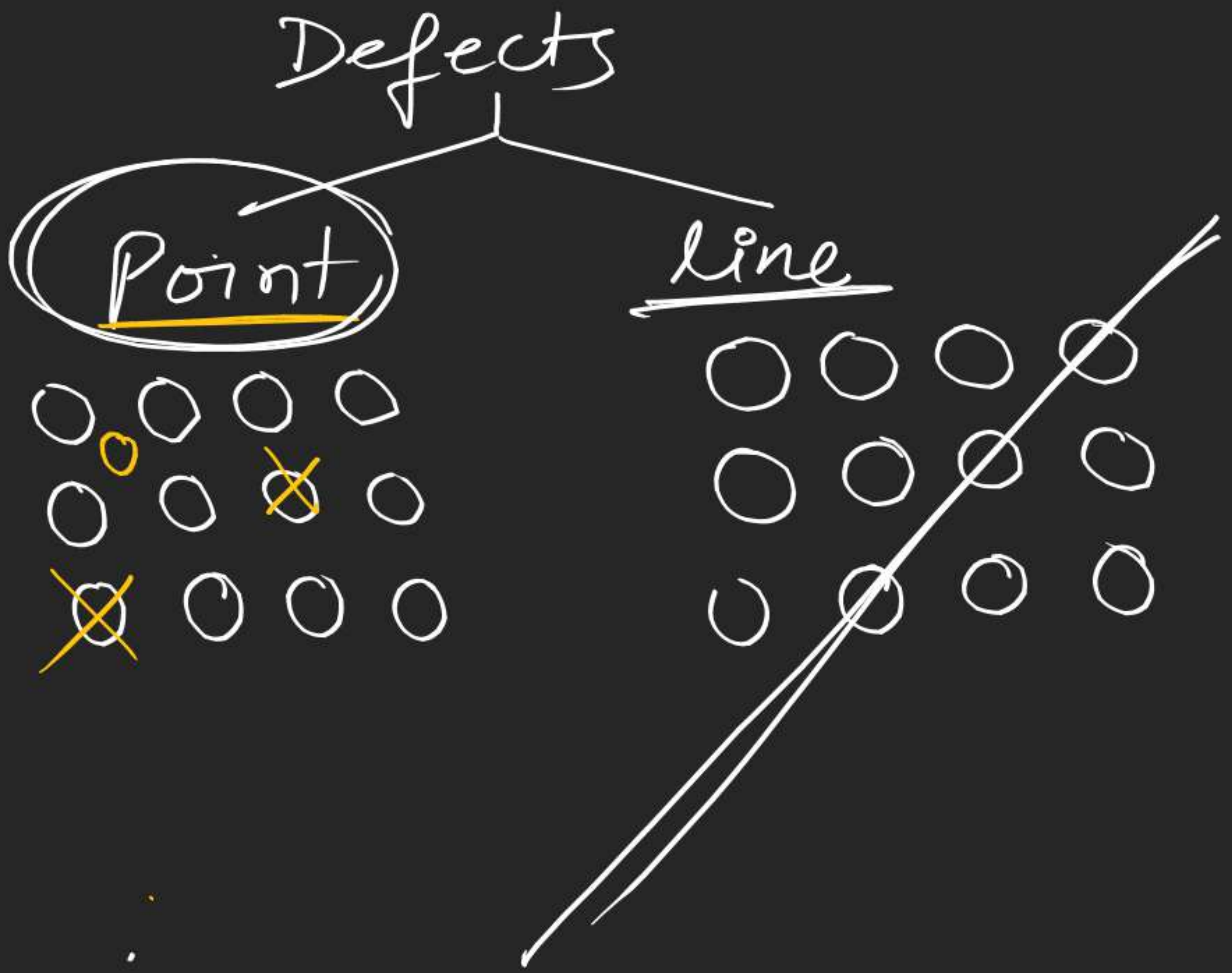
Defects :→ Deviation from ideal arrangement



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Point defect → Stoichiometric

→ Non-stoichiometric

→ Impurity

FeO $\quad Fe_{0.95}O$

$NaCl$

K^+ $\quad Br^-$

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<u>stoichiometric</u> <u>defects</u> :→ formula of the compound remains same

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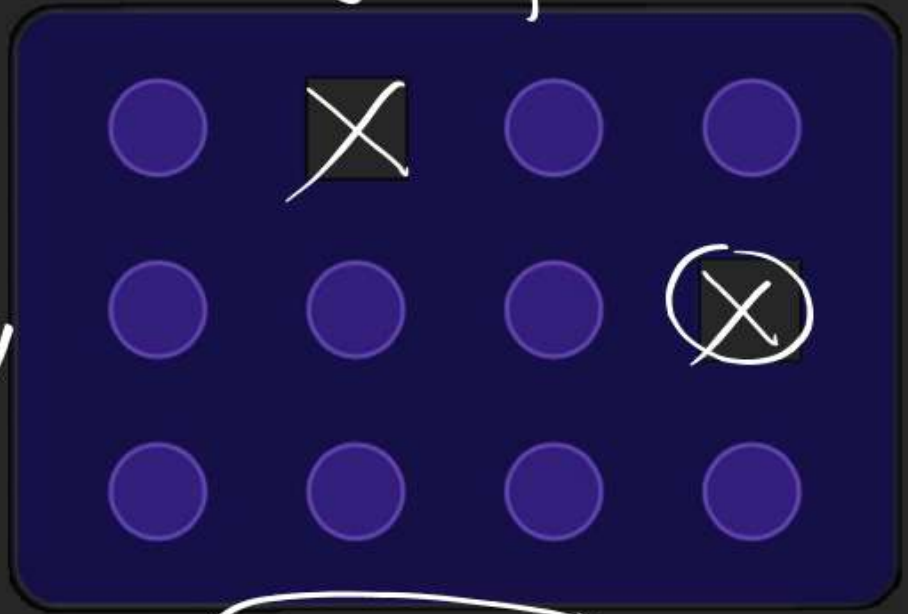
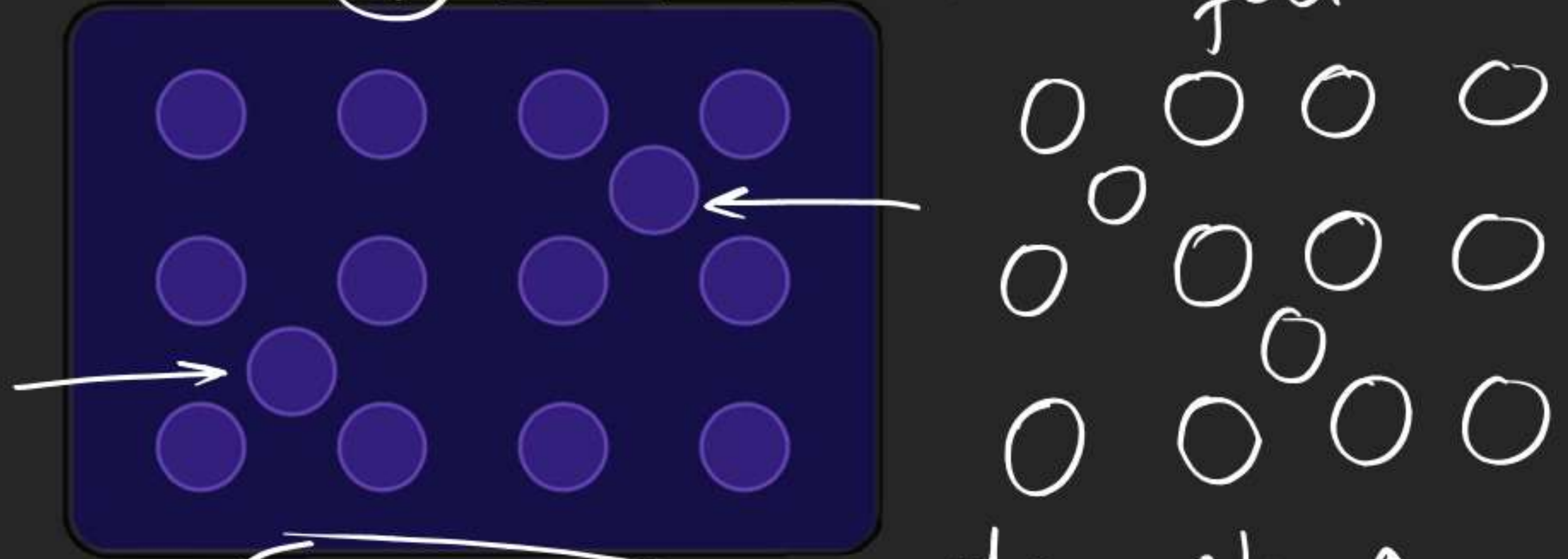
① Vacancy defect

density ↓



Vacancy defects

② Interstitial defect



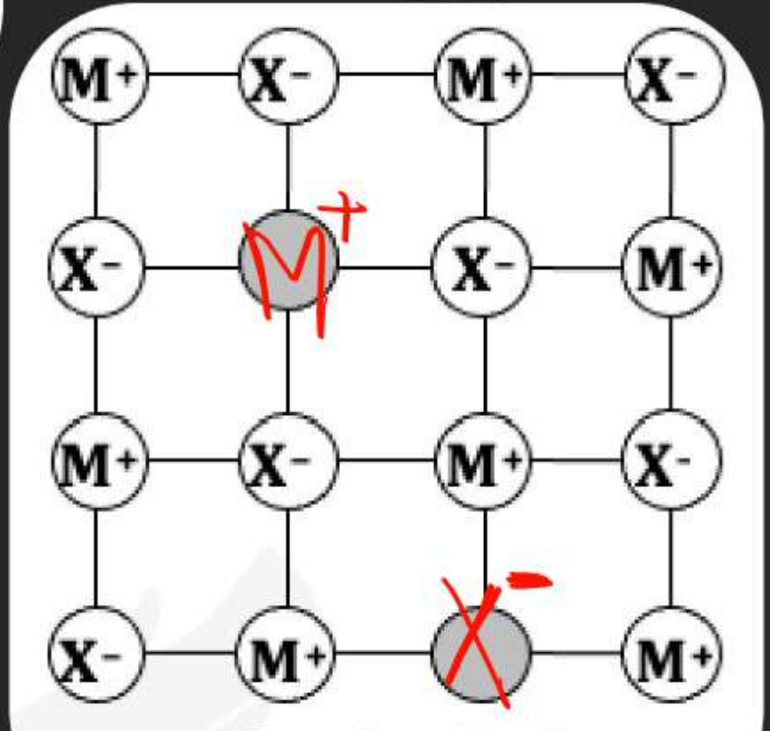
Interstitial defects

density ↑

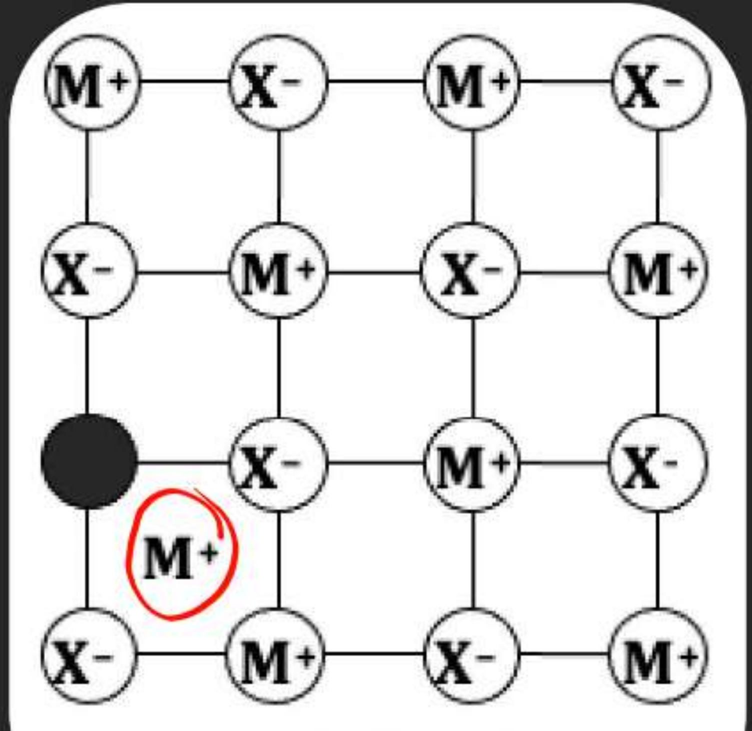
CaF_2

M^+

X^-

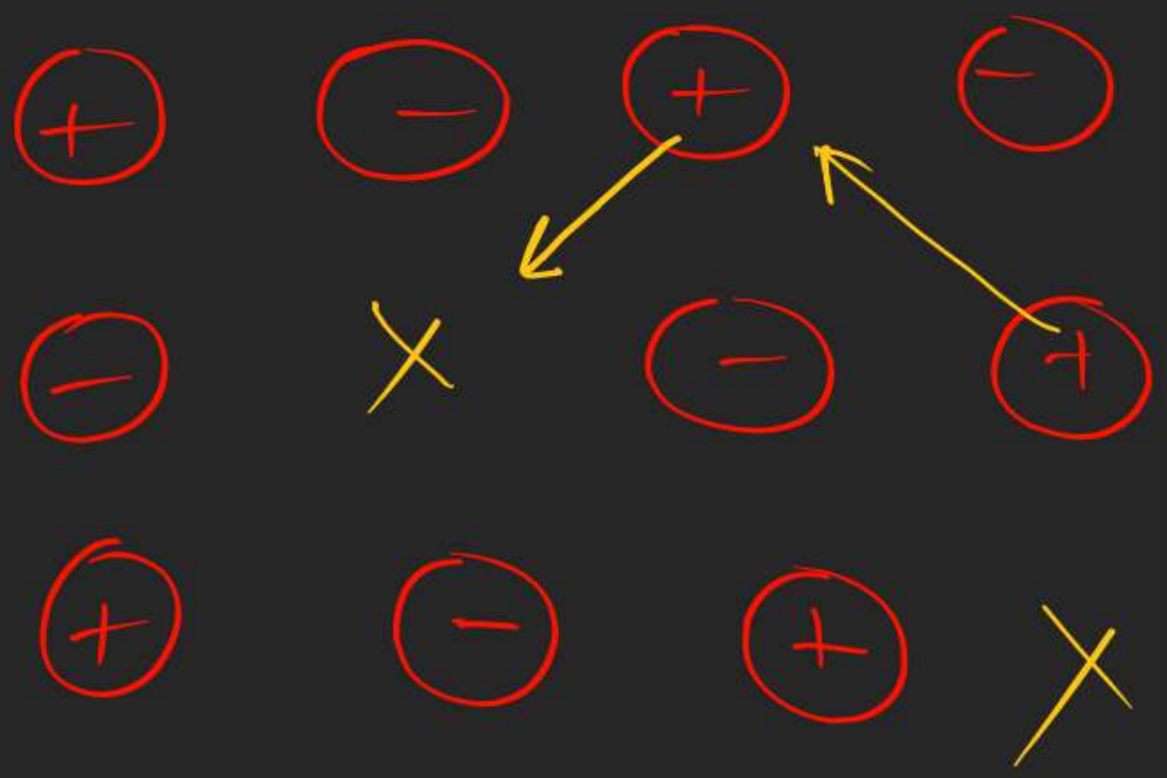


Schottky Defect



Frenkel Defect

Schottky defect :→ exist in ionic compound



density ↓

electrical conductivity ↑

→ In high coordination compound

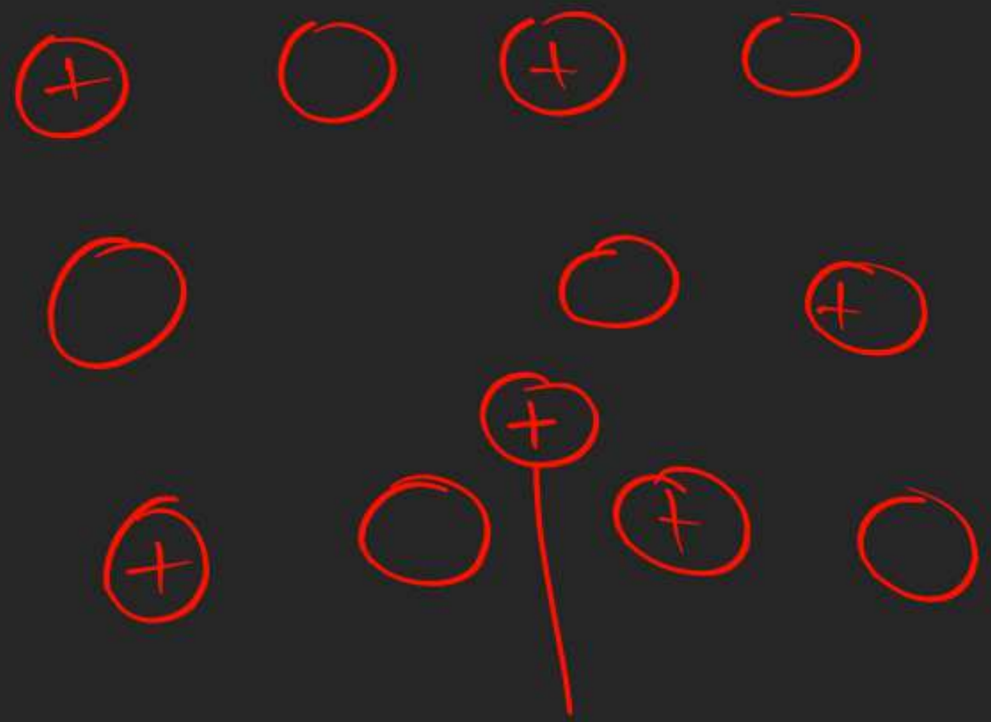
e.g $CsCl$

$NaCl$

KCl

$AgBr$

Frenkel defect :→ dislocation defect



Vacancy cum Interstitial defect

Cation

density — Same

electrical conductivity ↑

→ Mainly observed in low co-ordination no. compound. e.g ZnS

AgBr AgCl AgI

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Non-stoichiometric defect :→

Cation – metal ion

NaCl

FeO

① Metal excess defect

② metal deficiency defect

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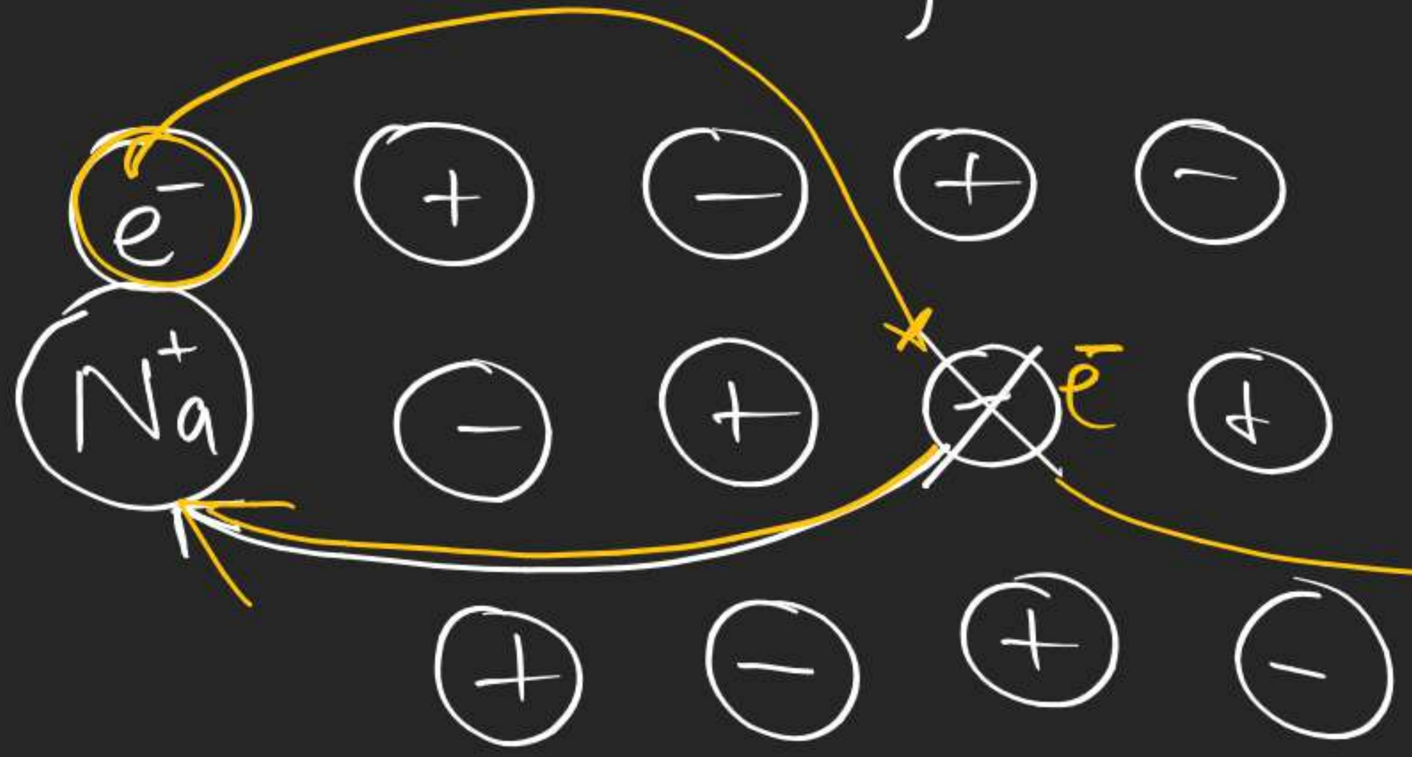
① Metal excess defect due to anionic vacancies



density ↓

electrical conductivity ↑

F-centre

Farbe (Colour)

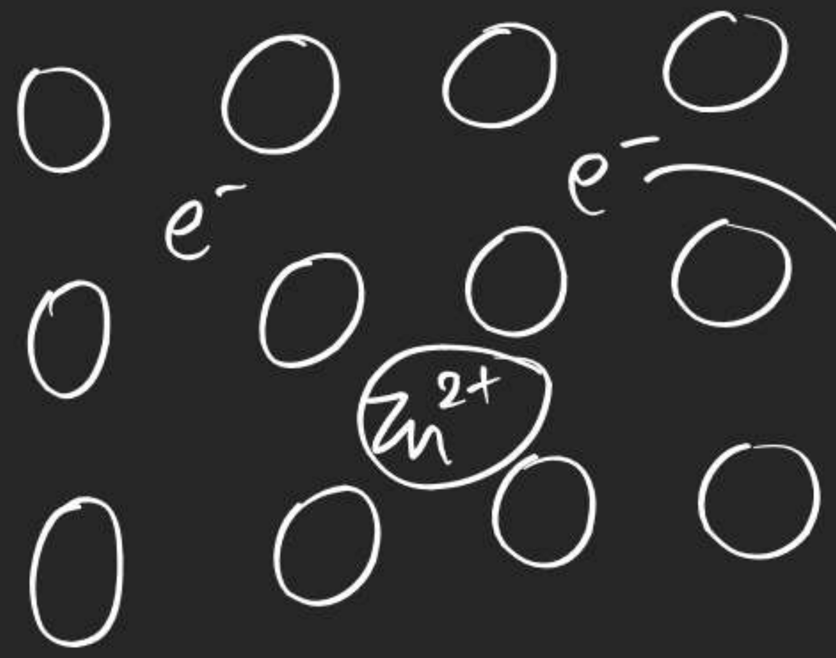
NaCl — Yellow

LiCl — Pink

KCl — Violet (lilac)

(ii) Metal excess defect due to extra metal ion

e.g. ZnO



density ↑

electrical conductivity

F-centre

$ZnO \longrightarrow$ yellow

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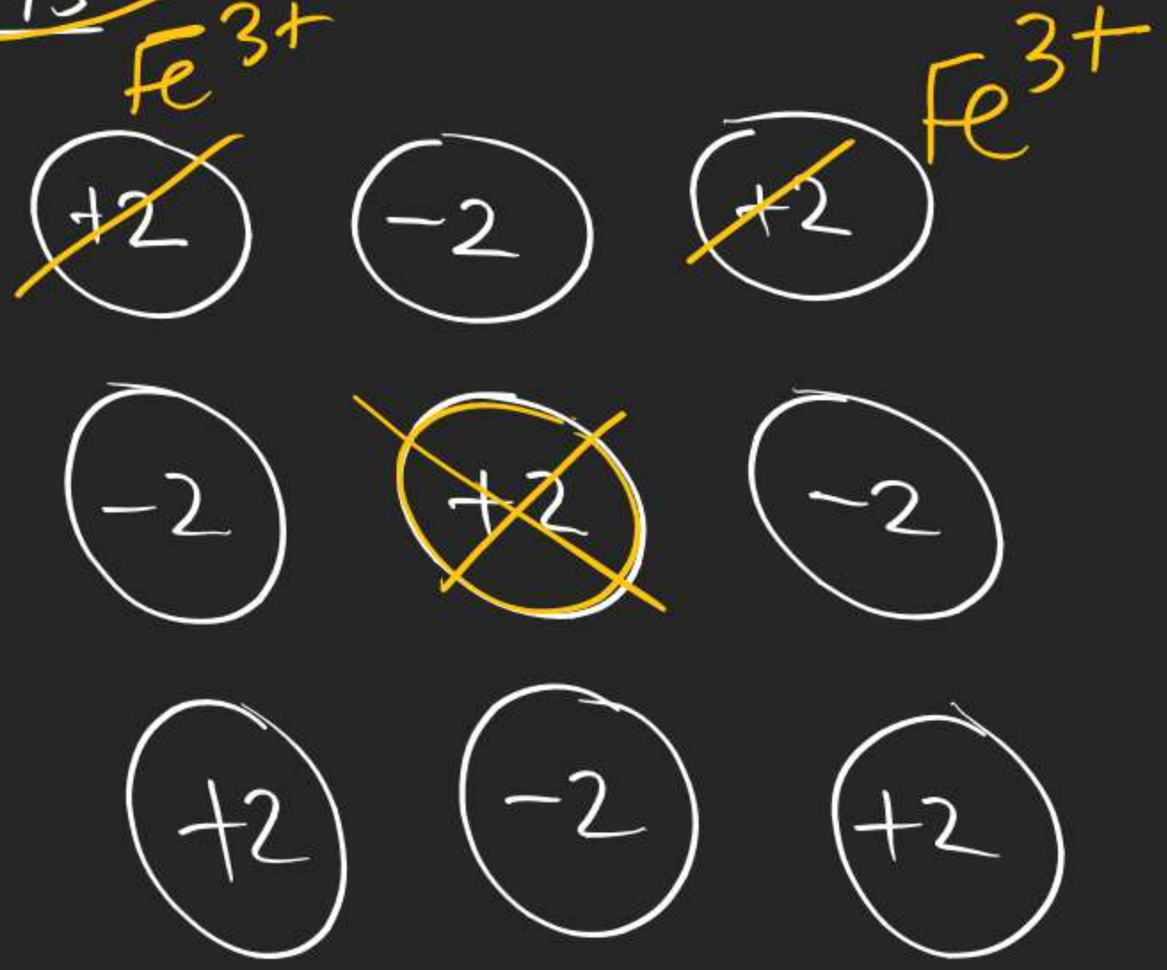
③ Metal deficiency defect due to missing cation

e.g. $Fe_{0.95}O$

Fe^{2+}

Fe^{3+}

Vacant



Fe^{2+} Fe^{3+}

Sn^{2+} Sn^{4+}

Pb^{2+} Pb^{4+}

1 Vacancy $\Rightarrow +2$

$2Fe^{2+} \longrightarrow 2Fe^{3+}$

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O-II

J-M → conductor

magnetic

new answer key

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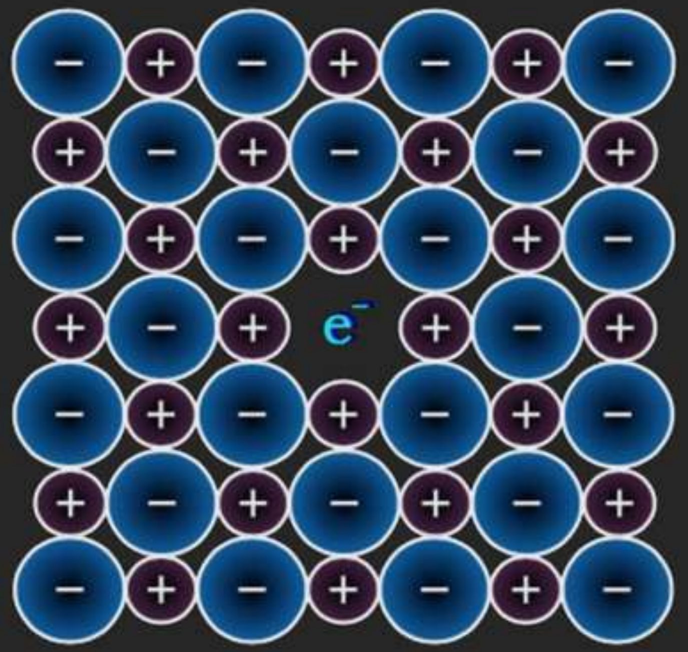
SOLID STATE



An F-centre in a crystal

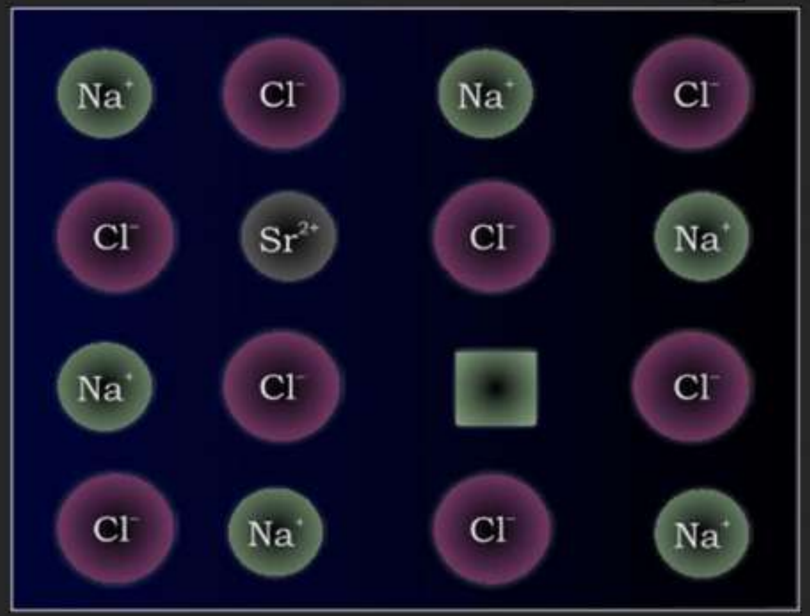


Fig. 1.31: *Introduction of cation vacancy in NaCl by substitution of Na^+ by Sr^{2+}*