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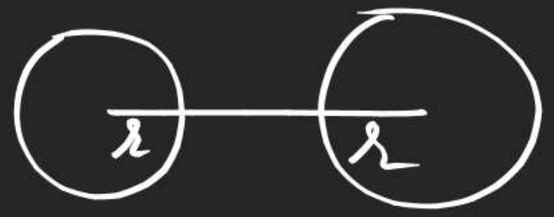
SOLID STATE

0-I | 14-24

20 (16)
21
23



$$= \frac{2r}{a} =$$

$$\sqrt{3}a = 4r$$

(21)

ABABAB — HCP 74%

ABCABC — FCC 74%

ABABCABABC 74%

ABBABBABBABB < 74%

(23)

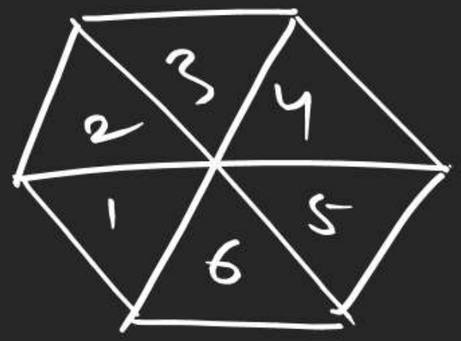
| x | x | x | x |

$4\left(\frac{2r}{\sqrt{3}}\right)$

$$= \frac{\sqrt{3}}{4}(2r)^2 \times 6 \times 4r\sqrt{\frac{2}{3}}$$

Vol. of prism

$24\sqrt{2}$



$= 4 \times 6 \times \sqrt{2} \times r^3$

$= 24\sqrt{2}\, r^3$ = Vol. of prism

(6) $= 8\sqrt{2} r^3 =$ Vol. of unit cell

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S-I

(8) Xe FCC $a = 620\ pm$

gm/cm^3

kg/m^3

$407 \times 10^{-12}\ m$

$407 \times 10^{-10}\ cm$

$\sqrt{2}a = 4r$

γ-I 16

S-1 6

(11) $d = \dfrac{Z \times M/N_A}{a^3}$

$= \dfrac{4 \times 197\ (gm)/N_A}{(407 \times 10^{-10}\ cm)^3}$

$\dfrac{4 \times 197 \times 10^{-3}/N_A}{(407 \times 10^{-12})^3}\ kg/m^3$

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Ionic solid : Mostly cations are smaller than anions. Therefore cations occupy the space (or voids or interstitial space) created by packing of anions

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Types of void

1. Triangular void

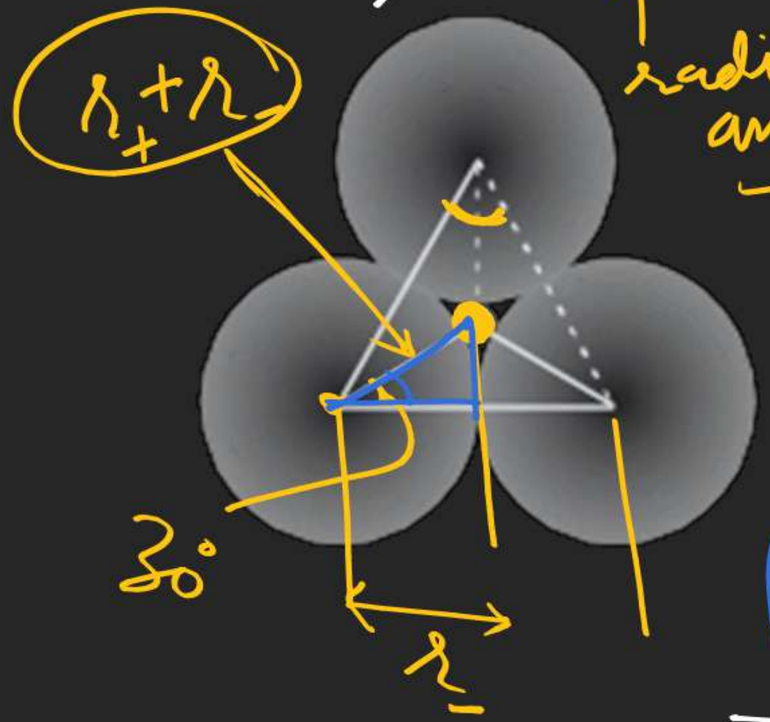
((Co-oridination no = 3

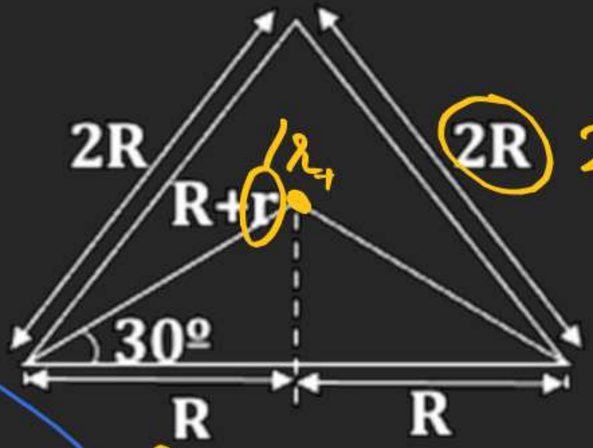
$\frac{r_+}{r_-}$ — radius of cation

↑ radius of anion

Minimum radius ratio or limiting radius ratio

$\frac{r_+}{r_-} = 0.155$





$2r_-$

$\frac{r_+ + r_-}{r_-} = \frac{1}{\cos 30^\circ}$

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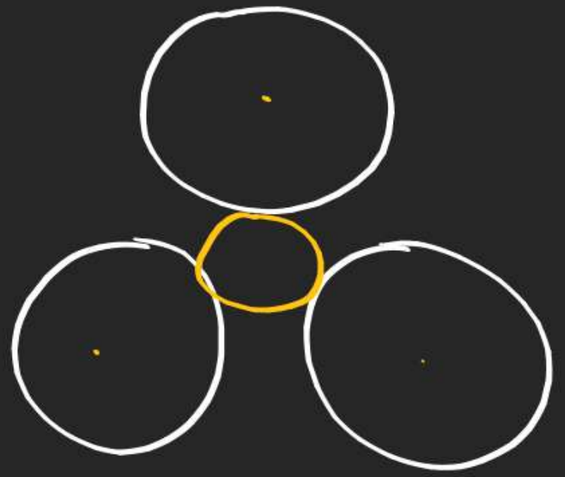

Upper limit < 0.225

range of radius ratio for triangular void

$$0.155 \leq \frac{r_+}{r_-} < 0.225$$

Tetrahedral void

↓

triangular base pyramid

Tetragonal

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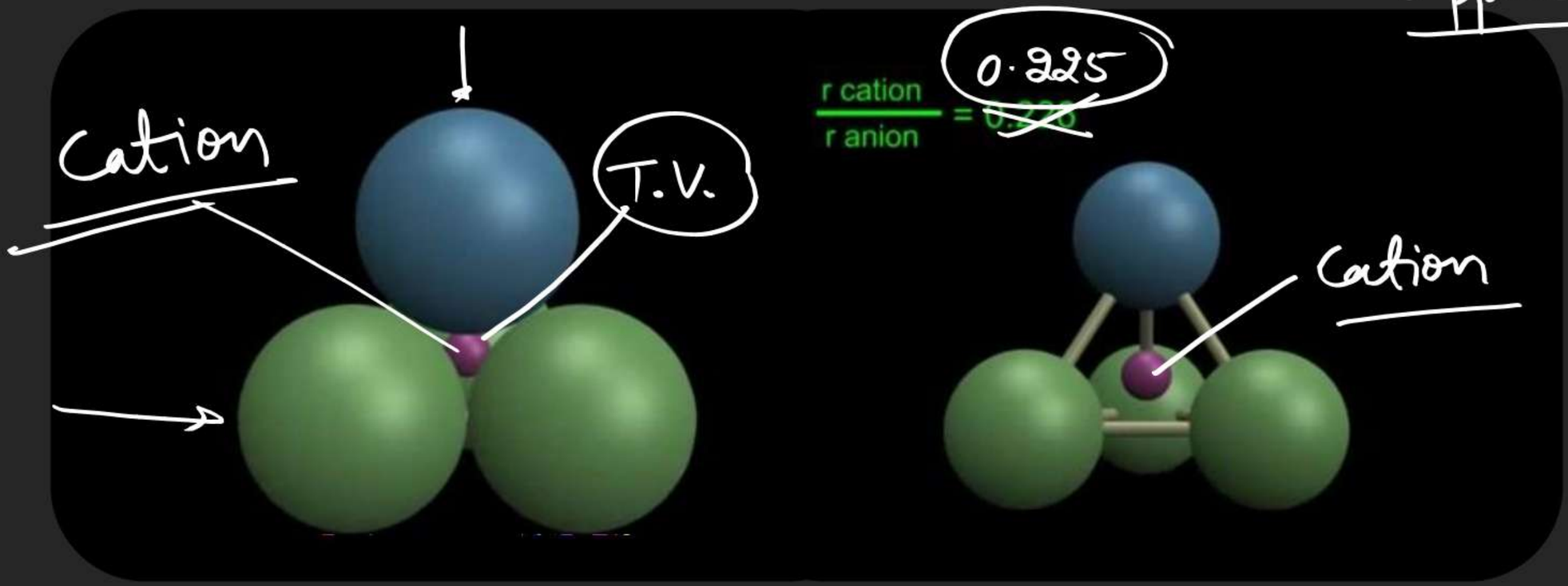
Tetrahedral void (T.V) [Co-ordination - 4]

Upper limit



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Tetrahedral void

$$0.225 \leq \frac{r_+}{r_-} < 0.414$$

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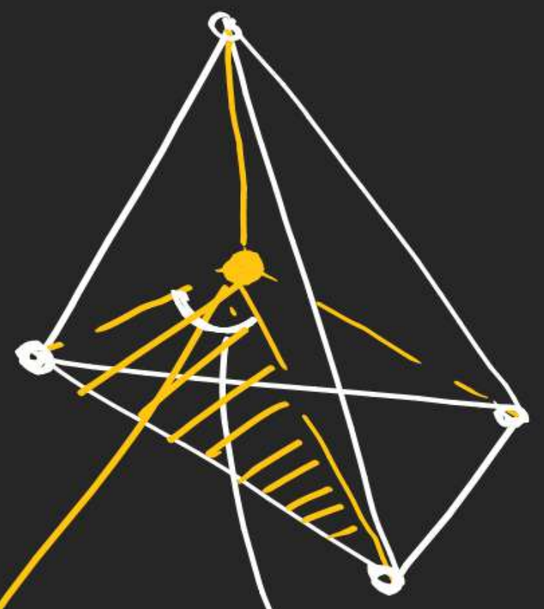
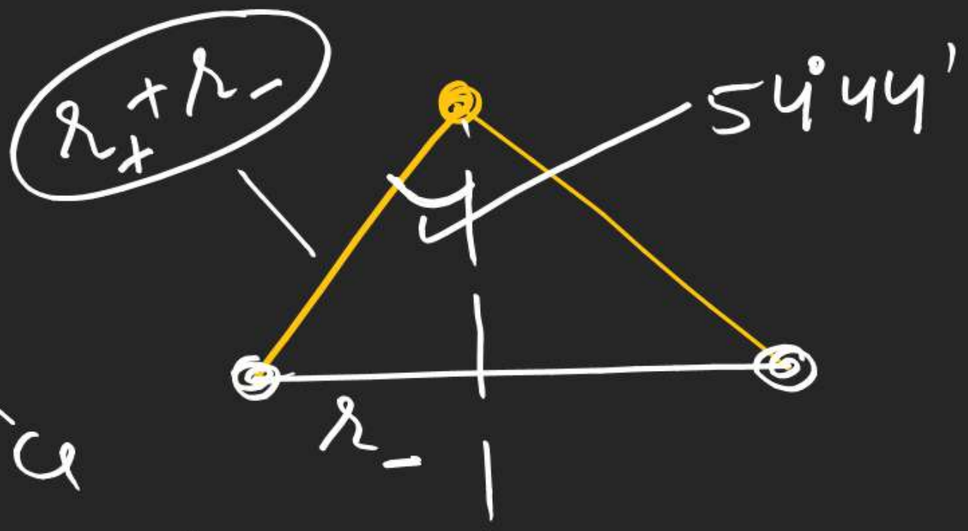
Tetrahedron



T.V



$$\frac{r_+ + r_-}{r_-} = \frac{1}{\sin 54°44'}$$

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

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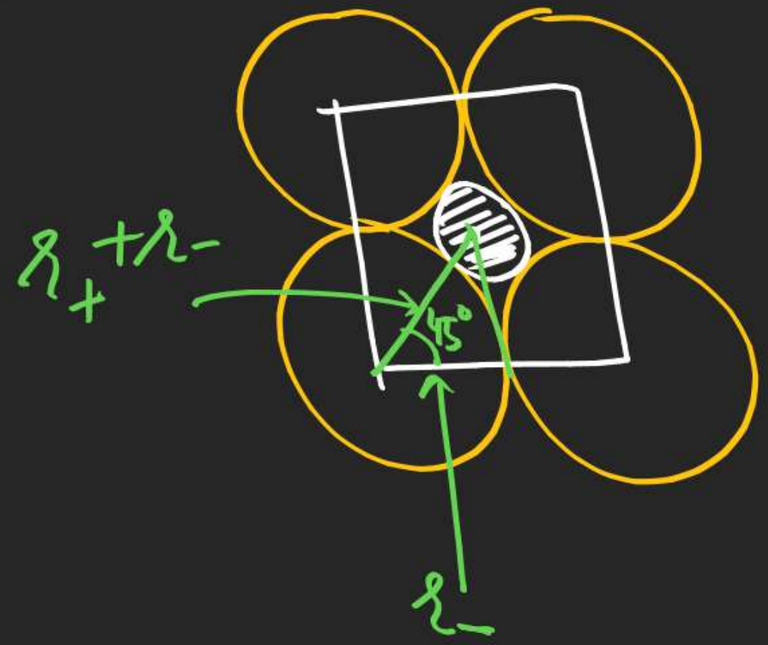
Octahedral void ((Coordination no = 6)

Octahedron → square base by pyramid



$$\frac{r_+ + r_-}{r_-} = \frac{1}{\sin 45^\circ} = \sqrt{2}$$

$$\frac{r_+}{r_-} = \sqrt{2} - 1$$

$$\frac{r_+}{r_-} = 0.414$$

Square planar void

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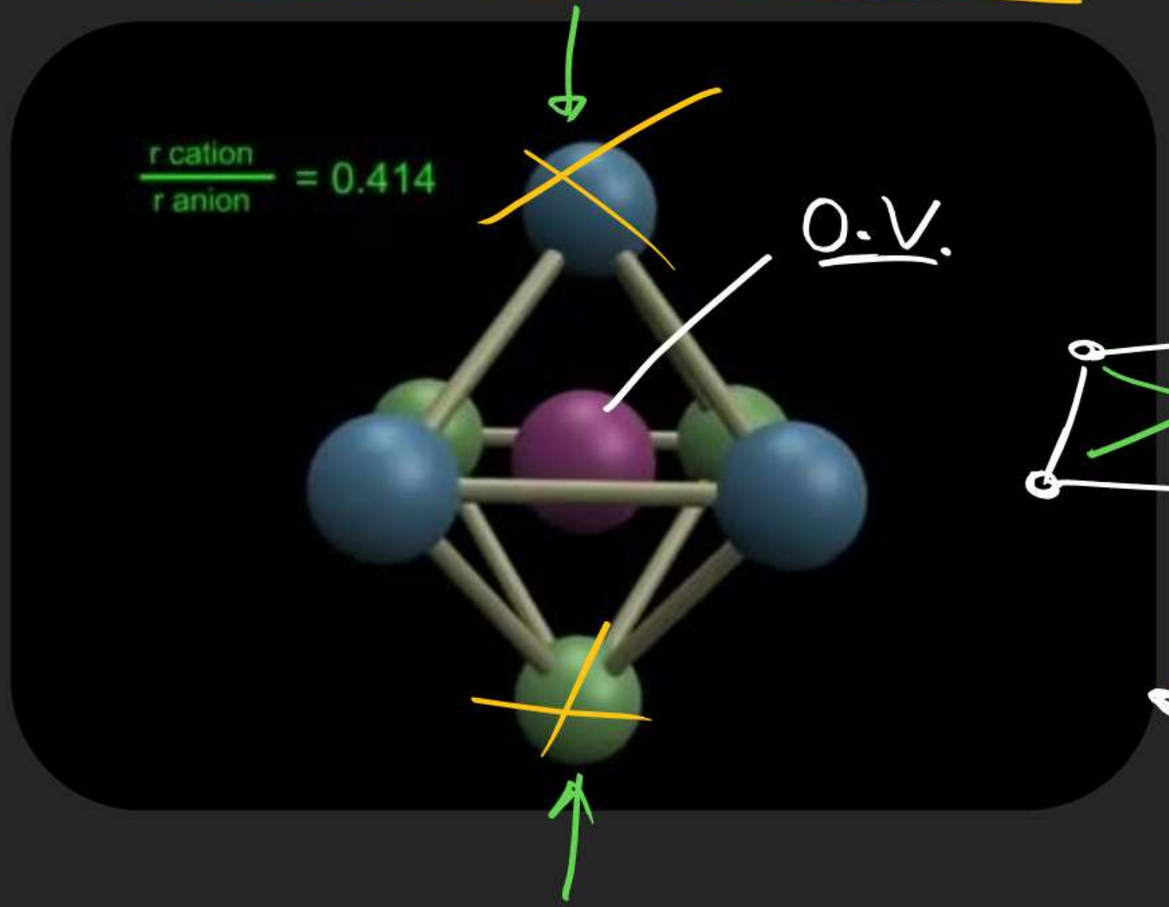
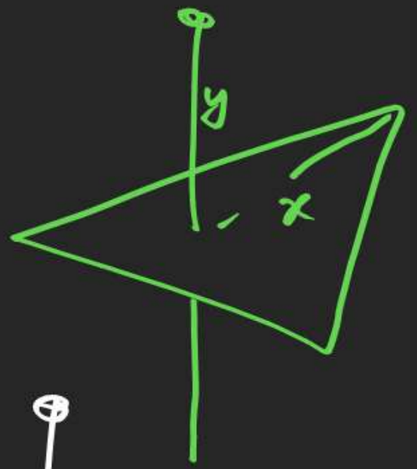
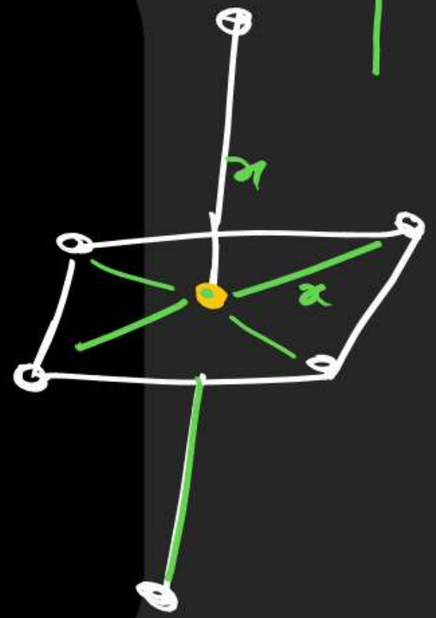
Octahedral void

$$0.414 \leq \frac{r_+}{r_-} < 0.732$$







sp^3d^2

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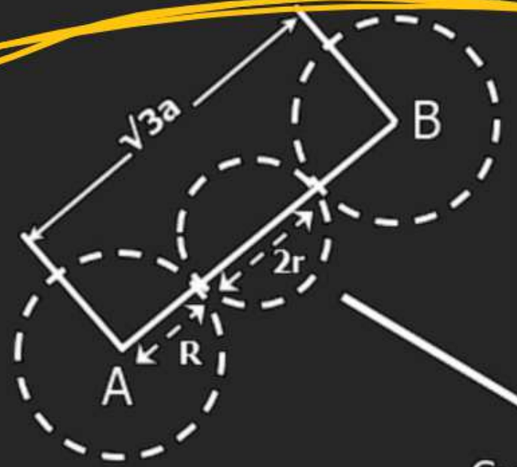
Cubic void

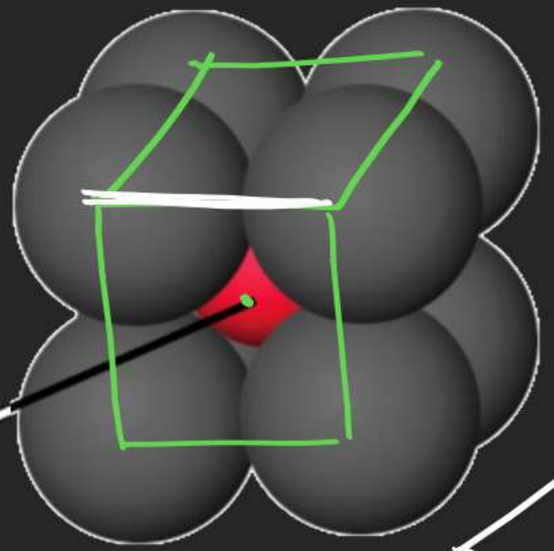
[C.No=8]

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

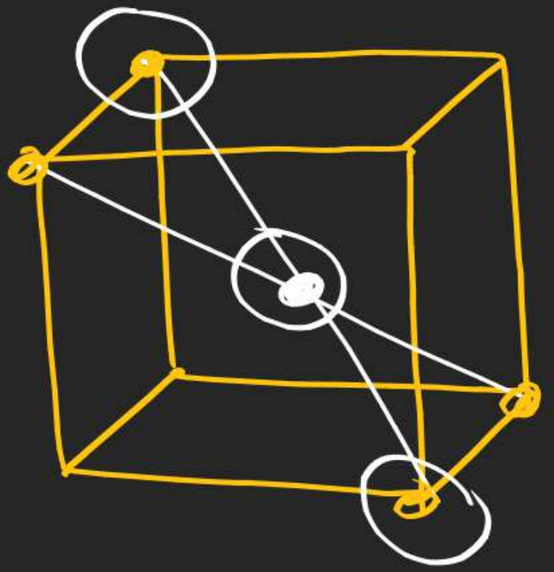
$$a = 2r_-$$

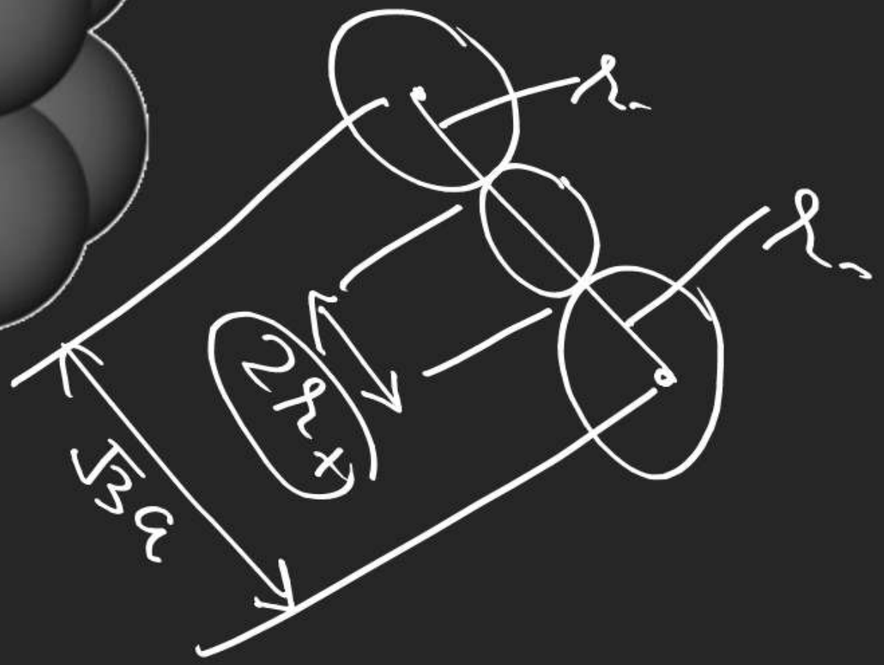
$$\frac{r_+}{r_-} = \sqrt{3} - 1 = 0.732$$





Cubical void





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$$0.732 \leq \frac{\ell_+}{\ell_-} < 1$$

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Limiting radius ratio for various types of sites			
Limiting radius ratio = r/R	Coordination Number of cation	Structural Arrangement (Geometry of voids)	Example
0.155 - 0.225	3	Plane Trigonal	Boron Oxide
0.225 - 0.414	4	Tetrahedral	ZnS, SiO_2
0.414 - 0.732	4	Square planner	–
0.414 - 0.732	6	Octahedral	NaCl, MgO_2
0.732 - 1.000	8	Cubic	CsCl

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T.V. & O.V in FCC lattice

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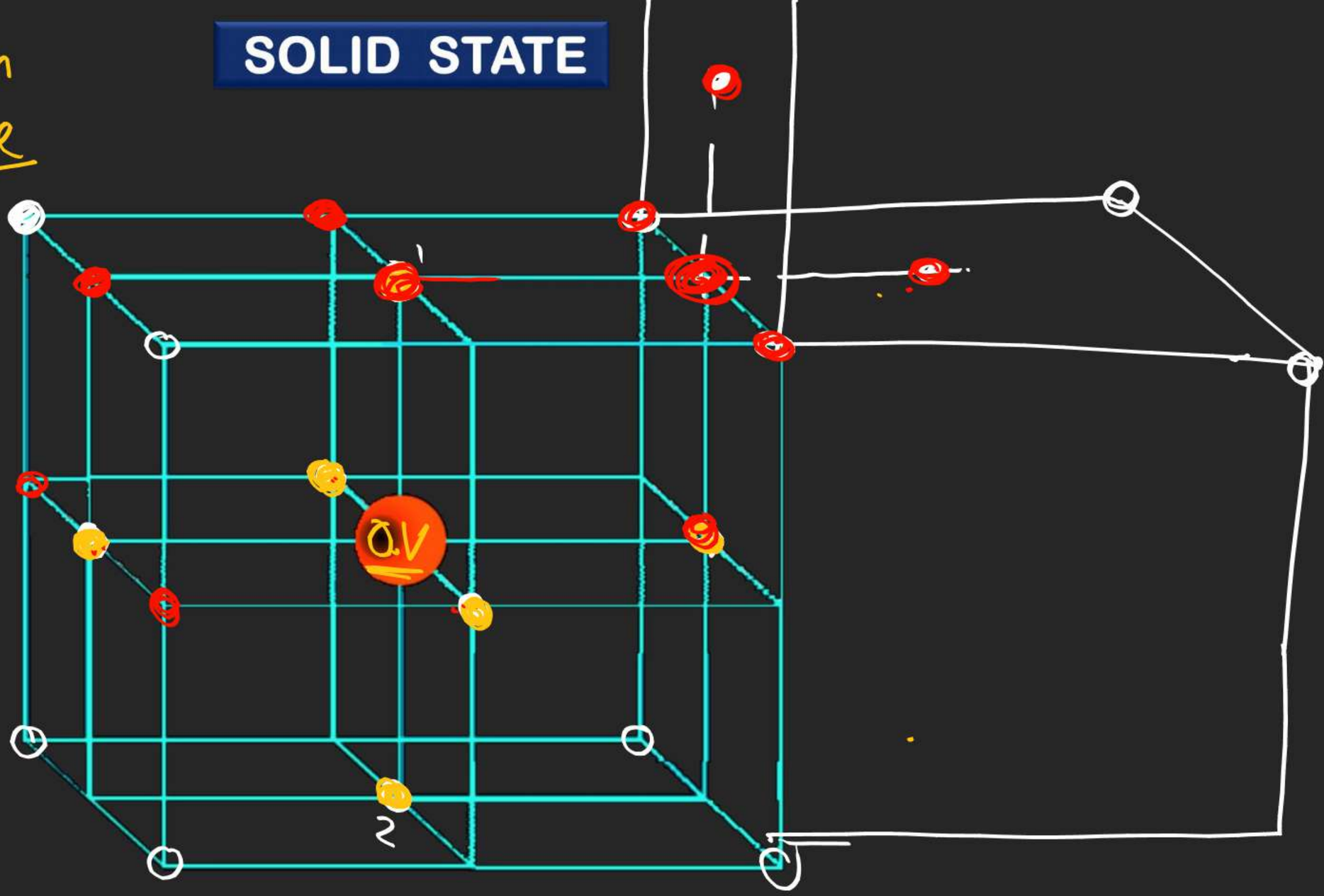
edge centre
= O.V
=



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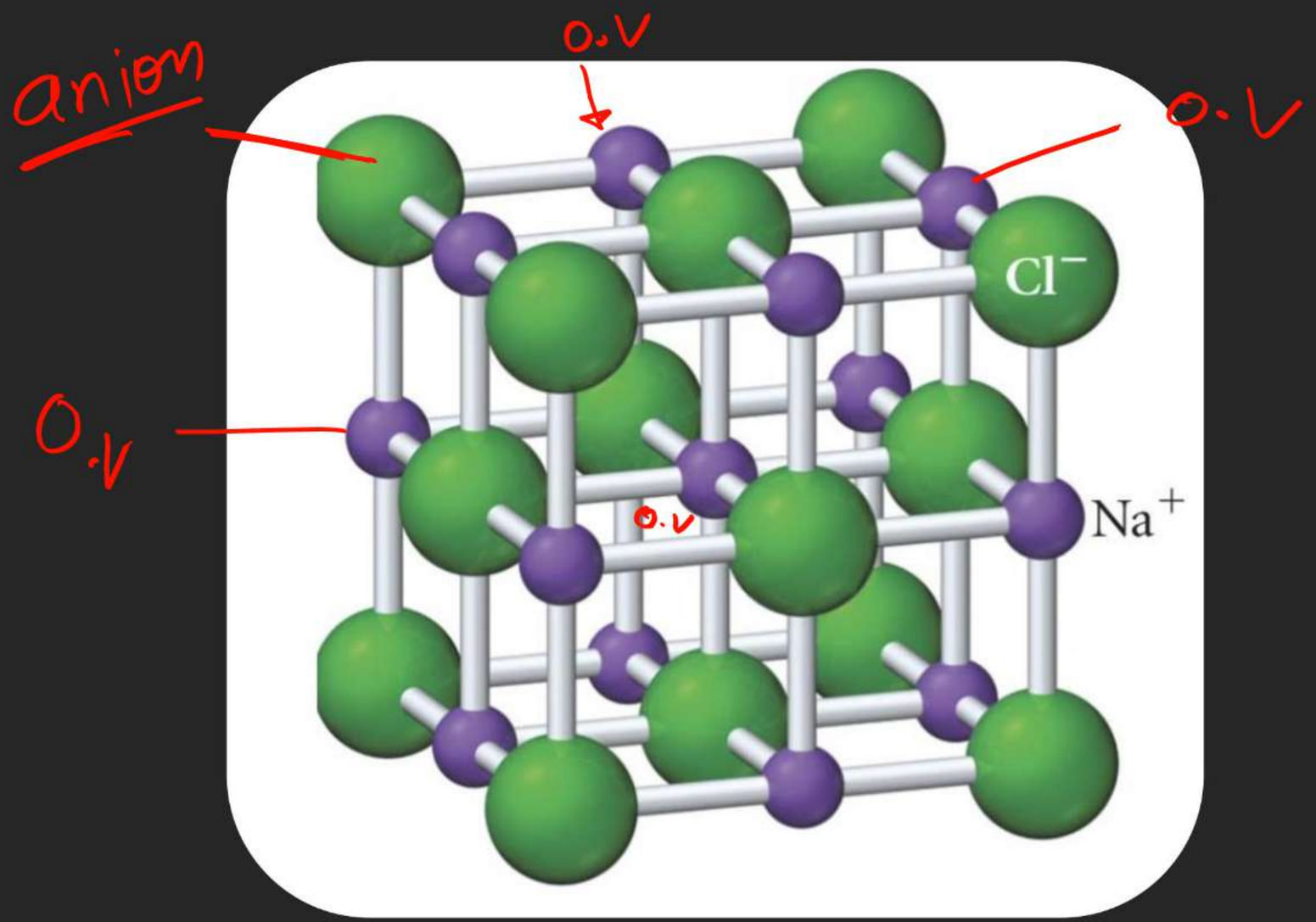

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0-I 25-28

5-I 15, 16