1. A compound is formed by two elements X and Y. The element Y forms cubic close packed arrangement and those of element X occupy one third of the tetrahedral voids. What is the formula of the compound?

[2023 (06 Apr Shift 1)]

(1) X_2Y_3

(2) X_3Y_2

(3) X_3Y

(4) XY_3

2. Number of crystal systems from the following where body centred unit cell can be found, is _____.

Cubic, tetragonal, orthorhombic, hexagonal, rhombohedral, monoclinic, triclinic

[2023 (06 Apr Shift 2)]

3. The correct relationships between unit cell edge length 'a' and radius of sphere 'r' for face-centred and body-centred cubic structures respectively are:

[2023 (10 Apr Shift 2)]

(1) $2\sqrt{2}r = a$ and $\sqrt{3}r = 4a$

(2) $r = 2\sqrt{2}a$ and $4r = \sqrt{3}a$

(3) $r = 2\sqrt{2}a$ and $\sqrt{3}r = 4a$

(4) $2\sqrt{2}r = a$ and $4r = \sqrt{3}a$

4. An atomic substance A of molar mass 12 g mol^{-1} has a cubic crystal structure with edge length of 300 pm. The no. of atoms present in one unit cell of A is (Nearest integer)

Given the density of A is $3.0\ g\ m\ m^{-1}$ and $NA_A = 6.02 \times 10^{23}\ mol^{-1}$

[2023 (11 Apr Shift 1)]

5. Sodium metal crystallises in a body centred cubic lattice with unit cell edge length of 4 Å. The radius of sodium atom is $___ \times 10^{-1}$Å. (Nearest integer)

[2023 (13 Apr Shift 2)]

6. Which of the following expressions is correct in case of a CsCl unit cell (edge length 'a')?

[2023 (15 Apr Shift 1)]

(1) $r_{Cs^+} + r_{Cl^-} = \frac{a}{2}$

(2) $r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}}{2}a$

(3) $r_{Cs^+} + r_{Cl^-} = \frac{a}{\sqrt{2}}$

(4) $r_{Cs^+} + r_{Cl^-} = a$

ANSWER KEYS

1. (1) **2.** (3) **3.** (4) **4.** (4) **5.** (17) **6.** (2)

1. (1)

Atoms of Element Y, are present in cubic close packing. In cubic close packing the number of atoms per unit cell is 4.
So, the effective number of element Y, per unit cell is 4
Element X, are present at one third of the tetrahedral voids.
Number of tetrahedral void =Twice the number of atoms in unit cell
Number of atoms of Element X are present unit cell $= \frac{1}{3} \times 8 = \frac{8}{3}$

$$\begin{array}{l} X \ : \ Y \\ \frac{8}{3} \ : \ 4 \\ 2 \ \ : \ 3 \end{array}$$

Formula of the compound $= X_2Y_3$

2. (3)

Bravais Lattice refers to the 14 different 3-dimensional configurations into which atoms can be arranged in crystals. The smallest group of symmetrically aligned atoms which can be repeated in an array to make up the entire crystal is called a unit cell. Crystal systems where body centred unit cell can be found are Cubic, orthorhombic and tetragonal
Hence, correct answer is 3

3. (4)

A face-centered cubic (fcc) unit cell contains a component in the center of each face in addition to those at the corners of the cube. The atoms touch each other along the face diagonal.

For $FCC: \ a\sqrt{2} = 4r$

$a = 2\sqrt{2}r$

A body-centered cubic (bcc) unit cell contains a component in the center of the cube in addition to those at the corners of the cube. The atoms touch each other along the body diagonal.

For $BCC \ : \ a\sqrt{3} = 4r$

4. (4)

The density of crystal can be calculated as follows,

$\rho = \frac{Z \times M}{N_A \times a^3}$

ρ =density of the unit cell
Z =Effective atomic number
M =Molar mass
N_A =Avogadro's number
a =Edge length of the unit cell

$3 = \frac{Z \times 12}{6.02 \times 10^{23} \times (3)^3 \times 10^{-24}}$

$Z = \frac{6.02 \times 10^{-1} \times 27}{4} = 4$

5. (17)

Edge length of the unit cell $(a) \ = \ 4 \text{ x } 10^{-8}$ cm
Radius of sodium atom (r) =?
Since, sodium crystallises in body centered cubic arrangement.
The radius of the atom and the edge length of the cubic unit cell are related as follows,
For bcc structure, $4r = \sqrt{3}a \Rightarrow r = \frac{\sqrt{3}}{4}a$

$r = \frac{1.732 \times 4 \times 10^{-8}}{4}$

$r = 1.732 \times 10^{-8}$ cm
$r = 17.3 \text{Å}$

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6. (2)

CsCl has body centered type structure in which Cs^+ occupies at corner of a cube and Cl^- occupies the centre of the cube.

$2r_{Cs^+} + 2r_{Cl^-} = \sqrt{3}a$ (where a is the edge length of the cube)

$r_{Cs^+} + r_{Cr} = \frac{\sqrt{3}}{2}a$