# JEE Main Chemistry Previous Year Questions With Solutions on Solid State

**1. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29 Å. The radius of sodium atom is approximately**

(a) 5.72 Å
(b) 0.93 Å
(c) 1.86 Å
(d) 3.22 Å

**Solution:**

For bcc, r = (√3/4)a
a = 4.29
r = (√3/4)×4.29
= 1.86
Hence option (3) is the answer.

**2. Which type of 'defect' has the presence of cations in the interstitial sites?**

(1) Vacancy defect
(2) Frenkel defect
(3) Metal deficiency defect
(4) Schottky defect

**Solution:**

The Frenkel defect is formed when an atom or smaller ion (usually cation) leaves its place in the lattice, creating a vacancy, and becomes an interstitial by lodging in a nearby location.
Hence option (2) is the answer.

**3. An element having an atomic radius of 0.14 nm crystallizes in an fcc unit cell. What is the length of a side of the cell?**

(1) 0.96 nm
(2) 0.4 nm
(3) 0.24 nm
(4) 0.56 nm

**Solution:**

For fcc unit cell, √2a = 4r
r = 0.14 nm
√2a = 4×0.14
a = 4×0.14/√2 = 0.396 ≈ 0.4 nm
Hence option (2) is the answer.

**4. The edge length of a face centered cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is :-**

(1) 144 pm
(2) 288 pm
(3) 398 pm
(4) 618 pm

**Solution:**
Given a = 508
Radius of cation, r = 110
$a = 2(r^+ + r^-)$
$508 = 2(110 + r^-)$
$2r^- = 508 - 220$
$r^- = 144$ pm
Hence option (1) is the answer.

**5. Lithium forms body centred cubic structure. The length of the side of its unit cell is 351 pm. Atomic radius of the lithium will be:-**
(1) 152 pm
(2) 75 pm
(3) 300 pm
(4) 240 pm

**Solution:**
For Body centred cubic structure, radius (r ) = $\sqrt{3}a/4$
Here edge length of unit cell, a = 351
So $r = \sqrt{3} \times 351/4 = 151.98 \approx 152$ pm
Hence option (1) is the answer.

**6. Copper crystallises in fcc lattice with a unit cell edge of 361 pm. The radius of copper atom is:-**
(1) 181 pm
(2) 108 pm
(3) 128 pm
(4) 157 pm

**Solution:**
For Face centred cubic structure, radius (r ) = $a/2\sqrt{2}$
Here edge length of unit cell, a = 361 pm
So $r = 361/2\sqrt{2} = 128$ pm
Hence option (3) is the answer.

**7. The radius of a calcium ion is 94 pm and of the oxide ion is 146 pm. The possible crystal structure of calcium oxide will be:-**
(1) Octahedral
(2) Tetrahedral
(3) Pyramidal
(4) Trigonal

**Solution:**
Radius ratio = radius of cation / radius of anion
$r^+/r^-$ = 94/146 = 0.643
The radius ratio lies in between 0.414 – 0.732 .
So the coordination number of calcium is 6.
The possible crystal structure of calcium oxide will be octahedral.

Hence option (1) is the answer.

**8. In a face centred cubic lattice, atom A occupies the corner positions and atom B occupies the face centre positions. If one atom of B is missing from one of the face centred points, the formula of the compound is :-**
(1) $A_2B_3$
( 2) $A_2B_5$
(3) $A_2B$
(4) $AB_2$

**Solution:**
No. of atom A per unit cell = 8×1/8 = 1
No. of atom B per unit cell = 5×1/2 = 2.5
So $AB_{2.5}$ or $A_2B_5$

Hence option (2) is the answer.

**9. Ammonium chloride crystallizes in a body centred cubic lattice with edge length of unit cell of 390 pm. If the size of chloride ion is 180 pm, the size of ammonium ion would be:**
(1) 158 pm
(2) 174 pm
(3) 142 pm
(4) 126 pm

**Solution:**
Given edge length of unit cell, a = 390 pm
Size of chloride ion, $r^-$ = 180 pm
$\sqrt{3}a/2 = r^+ + r^-$

$\sqrt{3}\times390/2 = 180 + r^-$
So $r^- = 337.75 - 180$
$= 157.75$ pm $\approx 158$ pm

Hence option (1) is the answer.

**10. Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M, is present as $M^{2+}$ and $M^{3+}$ in its oxide. Fraction of the metal which exists as $M^{3+}$ would be :-**
(1) 7.01%
(2) 4.08%
(3) 6.05%
(4) 5.08

**Solution:**
Oxidation state of oxygen = -2
For $M_{0.98}O$ to be neutral, total oxidation state of $M_{0.98}$ = +2
Let the fraction of $M^{3+}$ be x.
The fraction of $M^{2+}$ will be (0.98-x)
For the compound to be neutral,
$3x+2(0.98-x) = 2$
$3x+1.96 - 2x = 2$
$x = 2-1.96 = 0.04$
Fraction of the metal which exists as $M^{3+}$ would be = $0.04\times100/0.98 = 4.08$ %
Hence option (2) is the answer.

**11. In a monoclinic unit cell, the relation of sides and angles are respectively**
(1) $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90^0$
(2) $a \neq b \neq c$ and $\beta = \gamma = 90^0 \neq \alpha$
(3) $a = b \neq c$ and $\alpha = \beta = \gamma = 90^0$
(4) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^0$

**Solution:**
For a monoclinic unit cell, $a \neq b \neq c$ and $\beta = \gamma = 90^0 \neq \alpha$
Hence option (2) is the answer.

**12. CsCl crystallises in body centred cubic lattice. if 'a' is its edge length then which of the following expression is correct :**
(1) $rCs^+ + rCl^- = \sqrt{3}a/2$
(2) $rCs^+ + rCl^- = \sqrt{3}a$
(3) $rCs^+ + rCl^- = 3a$
(4) $rCs^+ + rCl^- = 3a/2$

**Solution:**
$Cs^+$ ion is in contact with $Cl^-$ ion at the nearest distance which is equal to √3a/2.
Hence option (1) is the answer.

**13. Which primitive unit cell has unequal edge lengths (a ≠ b ≠ c) and all axial angles different from 90°?**
(1) Monoclinic
(2) Triclinic
(3) Tetragonal
(4) Hexagonal

**Solution:**
Triclinic cell has unequal edge lengths and all axial angles different from 90°.
Hence option (2) is the answer.

**14. A compound of formula $A_2B_3$ has the hcp lattice. Which atom forms the hcp lattice and what fraction of tetrahedral voids is occupied by the other atoms?**
(1) hcp lattice-A, 2/3 Tetrahedral voids-B
(2) hcp lattice-A, 1/3 Tetrahedral voids-B
(3) hcp lattice-B, 1/3 Tetrahedral voids-A
(4) hcp lattice-B, 2/3 Tetrahedral voids-A

**Solution:**
Let n be the number of atoms of B used in packing.
No. of tetrahedral voids = 2n
If A occupies ⅓ tetrahedral voids, then A = (⅓)2n = (⅔)n
A:B = (⅔)n : n = (⅔) :1 = 2:3
Hence the formula is $A_2B_3$
Hence option (3) is the answer.

**15. The one that is extensively used as a piezoelectric material is**
(a) quartz
(b) amorphous silica
(c) tridymite
(d) mica.

**Solution:**
Quartz is used as a piezoelectric material.
Hence option (1) is the answer.

**16. At 100°C, copper (Cu) has fcc unit cell structure with cell edge length of x Å. What is the approximate density of Cu (in g cm–3) at this temperature? [Atomic mass of Cu = 63.55 u]**

(a) 205 /$x^3$
(b) 211 / $x^3$
(c) 105 / $x^3$
(d) 422 / $x^3$

**Solution:**

$d = ZM/N_Aa^3$
$Z = 4$
$M = 63.55$
$a = x$ Å $= x \times 10^{-8}$ cm
So $d = (4 \times 63.55)/(6.023\times10^{23} \times( x\times10^{-8})^3)$
$= (422/x^3)$ g/cm$^3$
Hence option (4) is the answer.

**17. All of the following share the same crystal structure except**

(1) RbCl
(2) CsCl
(3) LiCl
(4) NaCl

**Solution:**

CsCl has bcc arrangement. RbCl, LiCl and NaCl have fcc structure.
Hence option (2) is the answer.