# PRACTICE MCQs

CLASS 12 CHEMISTRY (TERM - I)

## SOLID STATE

BY

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learning simplified

**Question 1:**

The edge length of the unit cell in terms of the radius of spheres constituting body centred cubic unit cell

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

(b) $a = 2r$

(c) $a = 4r$

(d) $a = 2\sqrt{2}r$

**Answer: (a) $a = 4r/\sqrt{3}$**

As atoms in BCC lattice touch each other along the body diagonal

r + 2r + r = length of body diagonal

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

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

**Question 2:**

Which of the following is a molecular crystal?

(a) Dry ice

(b) Quartz

(c) Rock salt

(d) Diamond

**Answer: (a) Dry ice**

Ice is a molecular crystal in which the constituent units are molecules and the interparticle forces are hydrogen bonds.

**Question 3:**

In which of the following crystals alternate tetrahedral voids are occupied?

(a) NaCl

(b) ZnS

(c) $CaF_2$

(d) $Na_2O$

**Answer: (b) ZnS**

In ZnS structure, sulphide ions occupy all the lattice points while $Zn^{2+}$ ions are present in alternate tetrahedral voids.

**Question 4:**

How many unit cells are present in a cube-shaped ideal crystal of NaCl of mass 1.0 g?

(a) $5.14 \times 10^{21}$unit cells

(b) $1.28 \times 10^{21}$unit cells

(c) $1.71 \times 10^{21}$-unit cells

(d) $2.57 \times 10^{21}$unit cells

**Answer: (d) $2.57 \times 10^{21}$ unit cells**

Molar mass of NaCl=58.5

1g of NaCl contains =(1/58.5) moles of NaCl

1g of NaCl contains(1/58.5) x 6.022 x $10^{23}$molecule of NaCl in cube-shaped ideal crystal of NaCl (Rock salt type)

4 molecules of NaCl are present as $Cl^-$present occupy the FCC lattice=4 ions of $Ce^-$

$Na^+$occupy the octahedral site =4 ions of $Na^+$

1 unit cell contain 4 molecules of NaCl

1 molecule contain (1/4) unit cell

(1/58.5) x 6.022 x $10^{23}$molecule contains= ((1/58.5) x 6.022 x $10^{23}$ /4) unit cell.

Thus

1g of NaCl contain=$2.57\times10^{21}$ unit cell.

**Question 5:**

F-centre is

(a) Anion vacancy occupied by unpaired electron

(b) Cation vacancy occupied by electron

(c) Cation vacancy occupied by electron

(d) Anion presents in interstitial site.

**Answer: (a) Anion vacancy occupied by unpaired electron**

The anionic sites occupied by unpaired electrons are called F-centres. Such defects also impart colour to the crystals.

**Question 6:**

The fraction of the total volume occupied by the atoms present in a simple cube is

(a) π/4

(b) π/6

(c) π/3√2

(d) π/4√2

**Answer: (b) π/6**

Let the edge length of the cube be a and radius of atom be r.

Now, in simple cube, number of atoms present = (1/8) x 8 =1

So, volume occupied =1× (4 π /3) $r^3$

Now, in simple cube atoms at corners will be touching each other.

⇒a=2r

⇒r=(a/2)

Volume of cube = $a^3$

So, fraction of total volume occupied = [(4 π /3) $r^3$]/($a^3$)

= [(4/3) π x$(a/2)^3$]/($a^3$)

= (4/3) x π (1/2)

=(π/6)

**Question 7:**

Doping of AgCl crystals with $CdCl_2$ results in:

(a) Schottky defects

(b) Frenkel defects

(c) Substitutional cation vacancy

(d) Formation of F-centres

**Answer: (c) Substitutional cation vacancy**

Two $Ag^+$ ions will be replaced by one $Cd^{2+}$, so there is one vacancy for each $Cd^{2+}$

**Question 8:**

For orthorhombic system axial ratios are a ≠ b ≠ c and the axial angles are: -

(a) α = β = γ ≠ 90°

(b) α = β = γ =90°

(c) α = β = γ =90°, β =90°

(d) α ≠ β ≠ γ =90°

**Answer: (b) α = β = γ = 90°**

For orthorhombic system axial ratios are a ≠ b ≠ c and the axial angles are α = β = γ = 90°. Thus, all the three edge lengths are unequal but all the angles are equal. They are equal to $90^0$.

**Question 9:**

The edge length of the free cell is 508 pm. If radius of cation is 110 pm, the radius of anion is

(a) 110 pm

(b) 220 pm

(c) 285 pm

(d) 144 pm

**Answer: (d) 144 pm**

For FCC, $2r^+ + 2r^- = a$

Given: = a= 508 pm, $r^+ = 110$pm

Therefore, $2(110) + 2r^- = 508$

$r^-=144$ pm

**Question 10:**

What is the coordination number in a hexagonal close packed structure in three dimensions?

(a) 9

(b) 6

(c)12

(d)4

**Answer: (c) 12**

In hexagonal close packing, the top and the bottom lattice are similar with the geometry of a hexagon. Atoms are placed on the vertices and in the centre of the hexagon. And the middle layer has a triangular geometry, where the atoms are placed on the vertices of the triangle.

The centre atom in layer B of HCP structure is touched with 12 other atoms of the same cell. Thus, the Coordination number is 12.

**Question 11:**

Which of the following arrangements correctly represents ccp and hcp in three dimensions respectively?

(a) ABCABC.... and ABAB...

(b) ABAB... and ABCABC...

(c) Both have ABAB .... arrangement

(d) ABCABC.... arrangement

**Answer: (a) ABCABC.... and ABAB...**

ABAB....... and ACBACB........ arrangements correctly represent hexagonal and cubic close-packed structures respectively.

Note: AAAA type arrangement represents simple cubic structure.

ACBACB........ arrangement can also be represented as ABCABC........ arrangement.

**Question 12:**

Which of the following is true about the value of refractive index of quartz glass?

(a) Same in all directions

(b) Different in different directions

(c) Cannot be measured

(d) Always zero

**Answer: (a) Same in all directions**

Since quartz glass is an amorphous solid having a short range order of constituents. Hence, the value of the refractive index is the same in all directions, can be measured and not be equal to zero always.

**Question 13:**

$Ca^{2+}$ and $F^-$ are located in $CaF_2$ crystal, respectively at face centred cubic lattice points and in

(a) tetrahedral voids

(b) half of tetrahedral voids

(c) Octahedral voids

(d) half of octahedral voids

**Answer: (a) tetrahedral voids**

In $CaF_2$ crystal, $Ca^{2+}$ ions are present at all corners and at the centre of each face of the cube while F- ions occupy all the tetrahedral sites.

**Question 14:**

An element (atomic mass =100 g/mol) having bcc structure has unit cell edge 400 pm. Then, density of the element is:

(a) 10.376 $g/cm^3$

(b) 5.188 $g/cm^3$

(c) 7.289 g/cm$^3$

(d) 2.144 g/cm$^3$

**Answer: (b) 5.188 g/cm$^3$**

$\rho$= (Z x M)/ ($N_A$ x $a^3$)

= (2 x100)/ (6.023 x $10^{23}$x (400 x $10^{-10}$)$^3$)

=5.188 g/cm$^3$

**Question 15:**

Sodium metal crystallizes in a body centred cubic lattice with the cell edge, a = 4.29 Å. What is the radius of a sodium atom?

(a) 2.857 Å

(b) 1.601 Å

(c) 2.145 Å

(d) 1.86 Å

**Answer: (d) 1.86 Å**

In bcc lattice, atoms touch along the body diagonal of the cube, hence:

4r= √ 3 a

r= (√ 3 a)/ (4)

r= (√ 3 x 4.29)/ (4)

=1.86 Å

**Question 16:**

The crystal system of a compound with unit cell dimensions a=0.387, b=0.387, c=0.504 nm and α=β=90° and γ=120° is:

(a) cubic

(b) hexagonal

(c) orthorhombic

(d) rhombohedral

**Answer: (b) hexagonal**

The crystal system of a compound with unit cell dimensions:

a=0.387, b=0.387, c=0.504 nm, $\alpha=\beta=90^\circ$ and $\gamma=120^\circ$is hexagonal.

The dimensions are a=b≠c and $\alpha=\beta=\gamma$.

**Question 17:**

A compound is formed by two elements M and N. The element N forms hcp and atoms of M occupy 1/3 rd of octahedral voids. What is the formula of the compound?

(a) $M_2 N_3$

(b) MN

(c) $M_3 N_2$

(d) $MN_3$

**Answer: (a) $M_2 N_3$**

The ccp lattice is formed by the atoms of the element N.

Here, the number of tetrahedral voids generated is equal to twice the number of atoms of the element N.

According to the question, the atoms of element M occupy 1/3rd of the tetrahedral voids.

Therefore, the number of atoms of M is equal to 2x1/3 = 2/3rd of the number of atoms of N.

Therefore, ratio of the number of atoms of M to that of N is

M: N = 2/3 :1 = 2: 3

Thus, the formula of the compound is $M_2N_3$.

## Assertion Reason Based Questions

**In the following questions from 18 to 21 a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.**

(a) Both assertion and reason are true and the reason is the correct explanation of assertion.

(b) Both assertion and reason are true but the reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Assertion is false but reason is true.

**Question 18:**

**Assertion (A)**: The total number of atoms present in a face centered cubic unit cell is four.

**Reason (R)**: Face centered cubic unit cell has atoms at its corners, each of which is shared between eight adjacent unit cells and atom at the center of the six faces.

**Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.**

In the fcc unit cell, 8 atoms are present at the corners and 6 atoms are present at the face centres of the cube. So, the effective number of atoms =(1/2) x 8 +(1/2) +6

= 1+ 3

=4

(As the contribution of the atom at the corner is (1/8) and contribution of the atom at face centre is (1/2) per unit cell).

Therefore, both Assertion and Reason are correct and Reason is the correct explanation for Assertion.

**Question 19:**

**Assertion (A):** Due to Frenkel defect, there is no effect on the density of the crystalline solid.

**Reason (R):** In Frenkel defect, no cation or anion leaves the crystal.

**Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.**

A Frenkel defect is a type of defect in crystalline solids wherein an atom is displaced from its lattice position to an interstitial site, creating a vacancy at the original site and an interstitial defect at the new location within the same element without any changes in chemical properties.

No cation is anion are leaving the crystal. Only the cation is moving from one place to another place within the crystal. So, the density of crystalline solid will not change.

Reason is the correct explanation for assertion.

**Question 20**:

**Assertion (A)**: Amorphous solids possess a long-range order in the arrangement of their particles.

**Reason (R)**: The formation of amorphous solids involves very rapid cooling.

**Answer: (d) Assertion is false but reason is true.**

Amorphous solids do not possess a long -range order in the arrangement of their particles because their formation involves rapid cooling.

**Question 21:**

**Assertion (A):** In any ionic solid [MX] with Schottky defects, the numbers of positive and negative ions are the same.

**Reason (R):** Equal number of cations and anion vacancies are present.

**Answer: (a) Both assertion and reason are true and reason is the correct explanation of assertion.**

Schottky Defect occurs when oppositely charged ions leave their lattice site creating vacancies in such a way that electrical neutrality of crystal is maintained. It is generally seen in highly ionic compounds where a difference in size of cation and anion is small.

So, an equal number of cations and anions vacancies are present in the crystals with Schottky Defect.

**Question 22:**

The lattice site in a pure crystal cannot be occupied by _____

(a) Molecule

(b) Ion

(c) Electron

(d) Atom

**Answer: (c) Electron**

Each point in a lattice is known as lattice point which can be either atom, molecule or ion. It is joined together by a straight line to bring out geometry of lattice in pure crystal constituents. They are arranged in fixed stoichiometric ratio. Hence, existence of free electrons is not possible.

**Question 23:**

In CsCl structure, the coordination number of $Cs^+$ is _______.

(a) equal to that of $Cl^-$, i.e., 6

(b) equal to that of $Cl^-$, i.e., 8

(c) not equal to that of $Cl^-$, i.e., 6

(d) not equal to that of $Cl^-$, i.e., 8

**Answer: (b) equal to that of $Cl^-$, i.e., 8**

$Cl^-$ in CsCl adopt bcc type of packing hence the coordination of $Cs^+$ is equal to that of $Cl^-$, that is 8.

**Question 24:**

The Appearance of colour in solid alkali metal halides is generally due to

(a) vacancy defect

(b) F- centres

(c) interstitials

(d) metal deficiency defect

**Answer: (b) F-centres**

In F-centre defect in which an anionic vacancy in a crystal is filled by one or more unpaired electrons. These electrons absorb light in the visible region and emit colour. So, the appearance of colour in solid alkali metal halides is generally due to F-centre.

**Question 25:**

Which of the following statements is not true about amorphous solids?

(a) On heating they may become crystalline at certain temperature

(b) They may become crystalline on keeping for long time

(c) Amorphous solids can be moulded by heating

(d) They are anisotropic in nature

**Answer: (d) They are anisotropic in nature**

Amorphous solids are isotropic in nature because they have no long range order and any physical property will be the same in all direction. On the other hand, Anisotropic nature is a characteristic feature of crystalline solid.

**Question 26:**

What is the total volume of atoms in a face centred cubic unit cell of a metal? (r is atomic radius)

(a) $(12/3)\ \pi r^3$

(b) $(20/3)\ \pi r^3$

(c) $(16/3)\ \pi r^3$

(d) $(24/3)\ \pi r^3$

**Answer: (c) (16/3) $\pi r^3$**

For FCC crystal,

Number of atoms =4

Zeff in FCC unit cell =6 x (1/2) +(1/8) x8

=4

Volume of one atom = (4/3) $\pi r^3$

Total volume of atoms=4× ((4/3) $\pi r^3$)

= (16/3) $\pi r^3$

## Case Study Based Questions

**Question 27:**

Point defects explain about the imperfections of solids along with the types of point defects. Crystalline solids are formed by joining many small crystals. Different types of defects are found in crystals after the process of crystallization.

Point defects are accounted for when the crystallization process occurs at a very fast rate. These defects mainly happen due to deviation in the arrangement of constituting particles. In a crystalline solid, when the ideal arrangement of solids is distorted around a point/ atom it is called a point defect.

Defects or Imperfections in crystalline solid can be divided into four groups namely line defects, point defects, volume defects and surface defects. Historically, crystal point defects were first regarded in ionic crystals, not in metal crystals that were much simpler.

There are 3 types of point defects:

Stoichiometric defect

Frenkel defect

Schottky defect

(i) Schottky defect in crystals are observed when

(a) an ion leaves its normal site and occupies an interstitial site

(b) unequal number of cations and anions are missing from the lattice

(c) density of the crystal increases

(s) equal number of cations and anions are missing from the lattice

(ii) Which defect causes decrease in the density of the crystal?

(a) Frenkel

(b) Schottky

(c) Interstitial

(d) F-centre

(iii) Frenkel and Schottky defects are:

(a) Nucleus Defect

(b) Non-crystal defects

(c) Crystal defects

(d) Nuclear defects

(iv) When electrons are trapped into the crystal in anion vacancy the defect is known as

(a) Schottky defect

(b) Frenkel defect

(c) Stoichiometric defects

(d) F-centre

(v) The appearance of colour in solid alkali metal halides is generally due to

(a) Schottky defects

(b) Frenkel defects

(c) Interstitial defects

(d) F-centre

**Answer:**

**(i) (d) equal number of cations and anions are missing from the lattice**

Schottky defect is observed when equal number of cations and anions are missing from the lattice. This defect changes the density as a pair of ions are missing from the lattice

**(ii) (b) Schottky**

Schottky defect causes decrease in the density of a crystal. In this defect, equal number of cations and anions are missing from their position in the crystal lattice.

Frenkel defect does not alter the density of a crystal. In this defect, cation or anion occupies an interstitial position.

**(iii) (c) Crystal defects**

Both are stoichiometric crystalline defects.

**(iv) (d) F-centre**

**(v) (d) F-centre**

F - centres are the sites where anions are missing and instead electrons are present and the appearance of colour in solid alkali metal halides is generally due to F- centres.
The lattice sites containing the electrons trapped in the anion vacancies are called F−centres because they are responsible for imparting colour to the crystals (F=Farbe which is a German word for colour).

**Question 28:**

Packing refers to the arrangement of constituent units in such a way that the force of attraction among the constituent particles is maximum and the constituents occupy the maximum available space. In two-dimensions there are square close packing and hexagonal close packing. In three-dimensions, however, there are hexagonal close packing, cubic close packing and body-centered cubic packing.

hcp: AB ABABAB… arrangement co-ordination number is =12

percentage occupied space is= 74

ccp: ABC ABC ……arrangement coordination number is =12

percentage occupied is= 74 bcc: 68% space is occupied

coordination number is 8

Answer the following questions:

1. The empty space left in hcp in three-dimensions is

(a) 52.4%

(b) 80%

(c) 26%

(d) 74%

2. In closed packed lattice containing n particles, the number of tetrahedral and octahedral voids are

(a) 2n, n

(b) n, n

(c) n, 2n

(d) 2n, n/2

3. The pattern of successive layers of hcp arrangement can be designed as

(a) AB ABABAB…

(b) ABC ABCABC…

(c) AB ABC AB ABC …

(d) AB BA AB BA …

4.The space occupied by spheres in bcc arrangement is

(a) 70%

(b) 68%

(c) 74%

(d) 26%

5. A certain oxide of metal M crystallizes in such a way that $O^{2-}$ occupy hcp arrangement following AB AB ……. pattern the metal ions however, occupy $(2/3)^{rd}$ of the octahedral voids. The formula of the compound is

(a) $MO_2$

(b) $M_3O$

(c) $M_2O_3$

(d) $M_{(8/3)}\ O_3$

**Answer.**

**1. (c) 26%**

The space left in hcp in three-dimensions is 26%.

The space occupied by spheres in the hcp arrangement is 74%.

Packing fraction is = (Volume occupied by atoms)/(Volume of unit cell)

$=6 \times (4/3)\pi r^3 \times (1/24 \sqrt{2} r^3)$

=0.74

Rearranging and solving:

% Space occupied space=74%

The space in the hcp unit cell = 100-74%=26%.

**2. (c) 2n, n**

In closed packed lattice containing 'n'

particles, the numbers of tetrahedral and octahedral voids are 2n and n respectively.

For example, fcc unit cell has 4 atoms per unit cell. It has 8 tetrahedral and 4 octahedral voids respectively.

**3. (b) ABC ABCABC…**

The pattern of successive layers of cubic close packing (ccp) arrangement can be designated as ABC ABCABC.

Simple cubic arrangement can be designated as AAAAAA.

Hexagonal close packing (hcp) arrangement can be designated as ABABAB.

**4. (c) 68%**

The space occupied by spheres in bcc arrangement is 68%.

The empty space is 32%.

Packing fraction = (Z x (4/3) π $r^3$)/($a^3$)

= (2 x (4/3) π $r^3$)/(4r /√2)$^3$

=0.68%

=68%

**5. (c) $M_2O_3$**

The metal ions, however, occupy (2/3) rd of the octahedral voids. The formula of the compound is $M_2O_3$.

$O^{2-}$ ions occupy hcp arrangement. There are six O ions per unit cell. There are 6 octahedral voids per unit cell out of which (2/3) $^{rd}$ or (2/3) x 6=4 octahedral voids are occupied with metal ions.

The ratio of number of atoms M:O = 4:6=2: 3

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