PHYSICAL / INORGANIC CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 43

Total Marks : 42

Max. Time : 45 min.

Topic : Solid State

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.7	(3 marks, 3 min.)	[21, 21]
Subjective Questions ('–1' negative marking) Q.8 to Q.11	(4 marks, 5 min.)	[12, 15]
Comprehension ('–1' negative marking) Q.12 to Q.14	(3 marks, 3 min.)	[9, 9]

1. The density of KBr is 2.75 gm/cc length of the unit cell is 654 pm. K = 38, Br = 80, then what is true about the predicted nature of the solid.

(A) Solid has F.C.C. structure with co-ordination number = 6

(B) Solid has simple cubic structure with co-ordination number = 4

(C) Solid has F.C.C. structure with co-ordination numbers-1

(D) None of these

2. CsBr has b.c.c. structure with edge length 4.3 A. The shortest inter ionic distance in between Cs^+ and Br^- is:

(A) 3.72 (B) 1.86 (C) 7.44 (D) 4.3

3. The number of nearest neighbours and next near neighbours of a Na^+ ion in a crystal of NaCl are respectively

(A) $6Na^+$, $12Cl^-$ (B) $6Cl^-$, $6Na^+$ (C) $12Cl^-$, $6Na^+$ (D) $6Cl^-$, $12Na^+$

4. A solid has a b.c.c. structure. If the distance of closest approach between the two atoms is 1.73 Å. The edge belli length of the cell is ;

(A) $\sqrt{2}$ pm (B) $\sqrt{(3/2)}$ pm (C) 200 pm (D) 142.2 pm

5. The radius of metal atom can be expressed in terms of the length of a unit cell is :

(A) it is a/2 for simple cubic lattice (B) it is ($\sqrt{3}a/4$) for b.c.c. lattice

(C) it is ($a/2\sqrt{2}$) for F.C.C. lattice (D) All of the above.

6. Fraction of the total volume occupied by atoms in a simple cube is

(A) $\pi/6$ (B) $\sqrt{3\pi}/8$ (C) $\sqrt{2\pi}/6$ (D) $\pi/3$

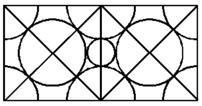
7. Lithium borohydride crystallizes in an orthorhombic system with 4 molecules per unit cell. The unit cell dimensions are a = 6.8 Å, b = 4.4 Å and c=7.2 Å. If the molar mass is 21.76, then the density of crystals is :

(A) 0.6708 g cm^{-2} (B) 1.6708 g cm^{-3} (C) 2.6708 g cm^{-3} (D) None of these.

8. Show by drawing a diagram that in the NaCl lattice each $Cl^{\ominus}$ ion occupies an octahedral void space provided by $Na^{\oplus}$ ions. How many $Cl^{\ominus}$ ions surround each $Cl^{\ominus}$ ion in the lattice?

9. A simple cubic lattice consists of eight identical spheres of radius R in contact, placed at the corners of a cube. What is the volume of the cubical box that will just enclose these eight spheres and what fraction of this volume is actually occupied by the spheres?

10. Copper has a face-centred cubic structure with a unit-cell edge length of 3.61Å. What is the size of the largest atom which could fit into the interstices of the copper lattice without distorting it?



(Hint.: Calculate the radius of the smallest circle in the figure)

BooSt YoUr PreViouS ConCept

Integer Answer Type

11. This section contains 2 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9.

(i) Potassium dichromate in alkaline solution, with 30% H_2O_2 produces K_3CrO_8. How many peroxide linkages are found in the structure of K_3CrO_8 ?

(ii) The sum of bond order and number of π-bond in C_2 molecule on the basis of molecular orbital theory is :

Comprehension # (Q.12 to Q.14)

A hydrogen atom when bonded with highly electronegative atom such as fluorine, oxygen etc acquires a positive charge. In consequence of this, such a hydrogen atom exerts an electro static attraction on other highly electronegative atom like fluorine, nitrogen or oxygen. There is thus a dipole-dipole or dipole ion attraction, which has been given name, hydrogen bond. This may be represented as, $\overset{\delta-}{X} — \overset{\delta+}{H} \cdots\cdots \overset{\delta-}{Y} — A$

Where X and Y are strongly electronegative atoms of fluorine, oxygen and nitrogen.

The hydrogen bond, a sort of polar link, is formed as the attraction between H and Y outweighs the repulsion between X and Y. But Y must be a small electronegative atom such as fluorine, oxygen or nitrogen.

Such a bonding is significant only with hydrogen because of the minute size of the almost bare proton which enables Y to make a close approach to the positive charge.

Maximum energy of H bond = 45 KJ/mol.

12. Hydrogen bonding with chlorine is rarely observed because :

(A) Chlorine atom is not sufficiently electronegative to form hydrogen bond.

(B) The charge density of the chlorine atom is greater.

(C) The electron affinity of chlorine is highest among the halogen.

(D) The size of the chlorine is greater.

13. Which of the following statement is true regarding the existence of X – H – Y type bond -

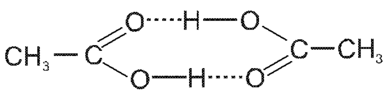
(A) The given type of bond rarely occurs because a hydrogen atom can accomodate two electrons only in the 1s orbital. The use of 2s will involve much higher energy.

(B) The hydrogen atom has metal like properties. The valency of hydrogen is always limited to one. Thus X–H–Y type of bond never exists.

(C) X–H–Y type of bonding may occur in the electron deficient molecules. The formation of X–H–Y type of bond occur like the three centre two electron bond in the electron deficient molecules.

(D) Both (A) & (C) are correct.

14. Acetic acid CH_3COOH, can form dimer $(CH_3COOH)_2$ in gaseous state



At 25°C equilibrium constant for dimerisation is 10^3 atm and for dimerisation $\Delta S°$ is, –0.16 KJ/mole/K

The dimerisation reaction is $2CH_3COOH \rightleftharpoons (CH_3COOH)_2$

What is the H bond energy in dimer of acetic acid in gaseous state for per mole hydrogen bond.

(A) 64.769 KJ (B) 32.385 KJ (C) 22.562 KJ (D) 50.79 KJ

Answer Key

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1.	(A)	**2.**	(A)	**3.**	(D)	**4.**	(C)	**5.**	(D)
6.	(A)	**7.**	(A)	**8.**	12	**9.**	$8R^3$, 52.38%	**10.**	0.53Å
11.	**(i)** 4 **(ii)** 4	**12.**	(D)	**13.**	(D)	**14.**	(B)		

Hints & Solutions

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1. $2.75 = \dfrac{Z \times 118}{(6.54 \times 10^{-8})^3 \times 6.023 \times 10^{23}}$ $\Rightarrow$ Z = 4 (fcc with NaCl type structure)

2. $r_+ + r_- = \dfrac{\sqrt{3}\,a}{2} = \dfrac{\sqrt{3} \times 4.3}{2} = 3.72$ Å

4. $2r = \dfrac{\sqrt{3}\,a}{2} \Rightarrow a = \dfrac{2(2r)}{\sqrt{3}} = \dfrac{2 \times 1.73}{1.73} = 2$Å = 200 pm

6. $\dfrac{1 \times \frac{4}{3}\pi r^3}{a^3} = \dfrac{\frac{4}{3}\pi r^3}{(2r)^3} = \dfrac{\pi}{6}$

7. $d = \dfrac{ZM}{a^3 N_A} = \dfrac{4 \times 21.76}{6.8 \times 10^{-8} \times 4.4 \times 10^{-8} \times 7.2 \times 10^{-8} \times 6.023 \times 10^{23}} = 0.6708\ g\ cm^{-2}$

9. $\dfrac{1 \times \frac{4}{3}\pi r^3}{a^3} \times 100 = \dfrac{\frac{4}{3}\pi r^3}{8R^3} \times 100 = 52.38\%$

10. $r_{octahedral} = 0.414\ R$

for FCC $4R = \sqrt{2}\ a$

$R = \dfrac{\sqrt{2}\ a}{4}$ $\Rightarrow$ $r = \dfrac{0.414\sqrt{2}\ a}{4} = \dfrac{0.414\sqrt{2} \times 3.61}{4} = 0.53$ Å

11. **(i)** K_3CrO_8 is a tetraperoxo species $K_3[Cr(O_2)_4]$.

(ii) Bond order = $\dfrac{1}{2}$ [bonding electrons – antibonding electrons]