DPP - Daily Practice Problems

Name : _____ Date : _____

Start Time : _____ End Time : _____

CHEMISTRY 30

SYLLABUS : Solid State-II (Mathematical analysis of cubic system and Bragg's equation, Crystal structure and Coordination number, Defects in crystal.

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE choice is correct.

Q.1 The formula for determination of density of unit cell is

(a) $\frac{a^3 \times N_A}{N \times M} g cm^{-3}$ (b) $\frac{N \times M}{a^3 \times N_A} g cm^{-3}$

(c) $\frac{a^3 \times M}{N \times N_A} g cm^{-3}$ (d) $\frac{M \times N}{a^3 \times N_A} g cm^{-3}$

Q.2 Potassium fluoride has NaCl type structure. What is the distance between K^+ and F^- ions if cell edge is a cm?

(a) 2a cm (b) a / 2 cm

(c) 4a cm (d) a / 4 cm

Q.3 The number of spheres contained (i) in one body centred cubic unit cell and (ii) in one face centred cubic unit cell, is

(a) In (i) 2 and in (ii) 4 (b) In (i) 3 and in (ii) 2

(c) In (i) 4 and in (ii) 2 (d) In (i) 2 and in (ii) 3

Q.4 Bragg's law is given by the which of the following equation?

(a) $n\lambda = 20\sin\theta$ (b) $n\lambda = 2d\sin\theta$

(c) $2n\lambda = d\sin\theta$ (d) $n\frac{\theta}{2} = \frac{d}{2}\sin\theta$

Q.5 How many unit cells are present in a cube-shaped ideal crystal of NaCl of mass 1.00g ? [Atomic masses: Na = 23, Cl = 35.5]

(a) 2.57×10^{21} unit cells (b) 5.14×10^{21} unit cells

(c) 1.28×10^{21} unit cells (d) 1.71×10^{21} unit cells

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 In the Bragg's equation for diffraction of X-ray, n represents
(a) quantumnumber (b) an integer
(c) Avogadro's numbers (d) moles

Q.7 In orthorhombic the value of a, b and c are respectively 4.2Å, 8.6Å and 8.3Å. Given the molecular mass of the solute is 155 gm mol^{-1} and density is 3.3 gm/cc, the number of formula units per unit cell is
(a) 2 (b) 3
(c) 4 (d) 6

Q.8 A solid has a structure in which 'W' atoms are located at the corners of a cubic lattice, 'O' atoms at the centre of edges and 'Na' atoms at the centre of the cube. The formula of the compound is
(a) $NaWO_2$ (b) $NaWO_3$
(c) Na_2WO_3 (d) $NaWO_4$

Q.9 Ferrous oxide has a cubic structure and each edge of the unit cell is 5.0 Å. Assuming density of the oxide as 4.0 gcm^{-3}, then the number of Fe^{2+} and O^{2-} ions present in each unit cell will be
(a) Four Fe^{2+} and four O^{2-}
(b) Two Fe^{2+} and four O^{2-}
(c) Four Fe^{2+} and two O^{2-}
(d) Three Fe^{2+} and three O^{2-}

Q.10 In A^+B^- ionic compound, radii of A^+ and B^- ions are 180 pm and 187 pm respectively. The crystal structure of this compound will be
(a) NaCl type (b) CsCl type
(c) ZnS type (d) Similar to diamond

Q.11 The structure of MgO is similar to NaCl. What would be the coordination number of magnesium?
(a) 2 (b) 4
(c) 6 (d) 8

Q.12 Most crystals show good cleavage because their atoms, ions or molecules are
(a) Weakly bonded together
(b) Strongly bonded together
(c) Spherically symmetrical
(d) Arranged in planes

Q.13 Certain crystals produce electric signals on application of pressure. This phenomenon is called
(a) pyroelectricity (b) ferroelectricity
(c) piezoelectricity (d) ferrielectricity

Q.14 The ratio of cationic radius to anionic radius in an ionic crystal is greater than 0.732. Its coordination number is
(a) 6 (b) 8
(c) 1 (d) 4

Q.15 The correct statement regarding F-centre is/are
(a) Electrons are held in the voids of crystals
(b) F–centre produces colour to the crystals
(c) Conductivity of the crystal increases due to F-centre
(d) All of these

Q.16 If NaCl is doped with 10^{-3}mol % $SrCl_2$, then the concentration of cation vacancies will be
(a) 1×10^{-3} mol %
(b) 2×10^{-3} mol %
(c) 3×10^{-3} mol %
(d) 4×10^{-3} mol %

Q.17 In the laboratory, sodium chloride is made by burning the sodium in the atmosphere of chlorine which is yellow in colour. The cause of yellow colour is
(a) Presence of Na^+ ions in the crystal lattice
(b) Presence of Cl^- ions in the crystal lattice
(c) Presence of electron in the crystal lattice
(d) Presence of face centrered cubic crystal lattice

Q.18 Which of the following is not a function of an impurity present in a crystal?
(a) Establishing thermal equilibrium
(b) Having tendency to diffuse
(c) Contributing to scattering
(d) Introducing new electronic energy levels

Q.19 In AgBr crystal, the ion size lies in the order $Ag^+ << Br^-$. The AgBr crystal should have the following characteristics
(a) Defectless (perfect) crystal
(b) Schottky defect only
(c) Frenkel defect only
(d) Both Schottky and Frenkel defects

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	

Space for Rough Work

Q.20 Which one of the following is the most correct statement?

(a) Brass is an interstitial alloy, while steel is a substitutional alloy

(b) Brass is a substitutional alloy, while steel is an interstitial alloy

(c) Brass and steel are both substitutional alloys

(d) Brass and steel are both interstitial alloys

Q.21 When electrons are trapped into the crystal in anion vacancy, the defect produced is known as

(a) Schottky defect

(b) Frenkel defect

(c) Stoichiometric defect

(d) F-centres

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct

(b) 1 and 2 are correct

(c) 2 and 4 are correct

(d) 1 and 3 are correct

Q.22 Which of the following statements are true about NaCl structure?

(1) Cl^- ions are in fcc arrangement

(2) Cl^- ions have coordination number of 6

(3) Each unit cell contains 4 NaCl molecules

(4) Na^+ ions have coordination number of 4

Q.23 Which of the following do not exhibits Frenkel defect?

(1) Sodium chloride

(2) Graphite

(3) Diamond

(4) Silver bromide

Q.24 Point defects are not present in

(1) molecular solids (2) amorphous solids

(3) liquids (4) ionic solids

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (hcp), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. These spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these three spheres touches three spheres of the bottom layer. Finally, the second layer is covered with third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be 'r'.

Q.25 The number of atoms in the HCP unit cell is

(a) 4 (b) 6

(c) 12 (d) 17

Q.26 The volume of this hcp unit cell is –

(a) $24\sqrt{2}r^3$

(b) $16\sqrt{2}r^3$

(c) $12\sqrt{2}r^3$

(d) $\frac{64}{3\sqrt{3}}r^3$

Q.27 The empty space in this hcp unit cell is

(a) 74% (b) 47.6%

(c) 32% (d) 26%

RESPONSE GRID					
	20. ⓐⓑⓒⓓ	**21.** ⓐⓑⓒⓓ	**22.** ⓐⓑⓒⓓ	**23.** ⓐⓑⓒⓓ	**24.** ⓐⓑⓒⓓ
	25. ⓐⓑⓒⓓ	**26.** ⓐⓑⓒⓓ	**27.** ⓐⓑⓒⓓ		

Space for Rough Work

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.28 Statement-1 : Space or crystal lattice differs in symmetry of the arrangement of points.

Statement-2 : $n\lambda = 2d \sin\theta$, is known as Bragg's equation.

Q.29 Statement-1: The presence of a large number of Schottky defects in NaCl lowers its density.

Statement -2 : In NaCl, there are approximately 10^6 Schottky pairs per cm^3 at room temperature.

Q.30 Statement-1 : Anion vacancies in alkali halides are produced by heating the alkali halide crystals with alkali metal vapour.

Statement -2 : Electrons trapped in anion vacancies are referred to as F -centres.

RESPONSE GRID	28.ⓐⓑⓒⓓ	29.ⓐⓑⓒⓓ	30.ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 30 - CHEMISTRY			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	40	Qualifying Score	60
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

CHEMISTRY SOLUTIONS

30

1. **(d)** Density of unit cell

$$= \frac{N \times \text{Mol.wt.}(M)}{a^3 \times \text{Avogadro no.}(N_A)} \text{g cm}^{-3}$$

2. **(b)** Distance between K^+ and F^- = $\frac{1}{2}$ × length of the edge

3. **(a)** The munber of spheres in one body centred cubic and in one face centred cubic unit cell is 2 and 4 respectively.

4. **(b)** $n\lambda = 2d\sin\theta$

5. **(a)** $\frac{1}{58.5} \times 6.023 \times 10^{23} = 1.029 \times 10^{22}$

A unit cell contains 4 Na^+ ion and 4 Cl^- ions

$\therefore$ Unit cell = $\frac{1.029 \times 10^{22}}{4} = 2.57 \times 10^{21}$ unit cell

6. **(b)** Bragg's equation is $n\lambda = 2d \sin\theta$

Where n is an integer i.e. 1, 2, 3, 4 etc.

7. **(c)** $Z = \frac{V \times N_A \times d}{M}$

$$= \frac{4.2 \times 8.6 \times 8.3 \times 10^{-24} \times 6.023 \times 10^{23} \times 3.3}{155} = 3.84 = 4$$

8. **(b)** In a unit cell, atoms (W) at the corner = $\frac{1}{8} \times 8 = 1$

atoms (O) at the centre of edges = $\frac{1}{4} \times 12 = 3$

atoms (Na) at the centre of the cube = 1

W : O : Na = 1 : 3 : 1, hence formula = $NaWO_3$

9. **(a)** Let the units of ferrous oxide in a unit cell = n, molecular weight of ferrous oxide (FeO) = 56 + 16 = 72 g mol^{-1},

Weigth of n units = $\frac{72 \times n}{6.023 \times 10^{23}}$,

Volume of one unit = (length of edge)^3

$= (5\text{Å})^3 = 125 \times 10^{-24}$ cm^3

Density = $\frac{\text{wt. of cell}}{\text{volume}}$,

$$4.0 = \frac{72 \times n}{6.023 \times 10^{23} \times 125 \times 10^{-24}}$$

$$n = \frac{3079.2 \times 10^{-1}}{72} = 42.7 \times 10^{-1} = 4.27 \approx 4$$

10. **(b)** $r_+ / r_- = \frac{180}{187} = 0.962$ which lies in the range of 0.732– 1.000, hence co-ordination number = 8 i.e. the structure is CsCl type.

11. **(c)** Mg has 6 co-ordination number (fcc structure)

12. **(d)** Crystals show good cleavage because their constituent particles are arranged in planes.

13. **(c)** The phenomenon is called piezoelectricity.

14. **(b)** When radius ratio is between 0.732 – 1, then co-ordination number is 8 and structural arrangement is body-centred cubic.

15. **(d)** All the given statements are correct about F -centres.

16. **(a)** As each Sr^{2+} ion introduces one cation vacancy, therefore concentration of cation vacancies = mol % of $SrCl_2$ added.

17. **(c)** Yellow colour on heating NaCl in presence of Na is due to presence of electrons in anion vacancies (F -centres)

18. **(a)** Impurity present in a crystal does not establish thermal equilibrium.

19. **(c)** AgBr exhibits Frenkel defect due to large difference in the size of Ag^+ and Br^- ions.

20. **(b)** Brass, Cu = 80%, Zn = 20% is substitutional alloy.

Steel is an interstitial alloy because it is an alloy of Fe with C, C atoms occupy the interstitial voids of Fe crystals.

21. **(d)** F -centres are the sites where anions are missing and instead electrons are present which are responsible for colour.

22. **(a)** In NaCl crystal, Na^+ ions have coordination number 6. Statements (1), (2) and (3) are correct statements.

23. **(a)** AgBr exhibits Frenkel defect due to large difference in the size of Ag^+ and Br^- ions. Statements, (1), (2) and (3) are correct choices.

24. **(a)** Point defects are present in ionic solids.

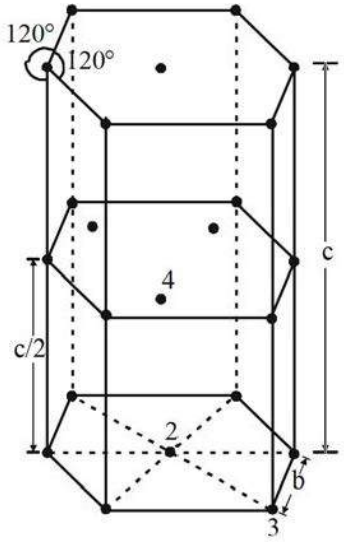
25. **(b)** In 1 unit cell of hcp, the number of atoms can be calculated as follows

Number of atoms in a unit cell of hcp

$$= 12 \times \frac{1}{6} + 2 \times \frac{1}{2} + 3 = 6$$

i.e. the correct answer is option (b)

[: in a hexagonal close packing (hcp) the spheres in the first and third layers are vertically aligned. (See figure below]



26. (a) The volume of hcp unit cell is given by the formula:-

Volume of hexagon = Area of base × height

$$= 6 \times \frac{\sqrt{3}}{4}(2r)^2 \times 4r\sqrt{\frac{2}{3}} = 24\sqrt{2}\,r^3$$

i.e. the correct answer is option (a)

27. (d) In a hcp unit cell the space occupied is 74%, as calculated below

$$\text{Packing fraction} = \frac{\text{Volume of the atoms in a unit cell}}{\text{Volume of a unit cell}}$$

$$= \frac{6 \times \frac{4}{3}\pi r^3}{24\sqrt{2}\,r^3} = \frac{\pi}{3\sqrt{2}} = \frac{22}{7} \times \frac{1}{3\sqrt{2}}$$

$$= 0.74 \text{ or } 74\,\%$$

$\therefore$ Empty space in hcp unit cell = (100−74)% = 26%

i.e. the correct answer is option (d).

28. (b) Space or crystal lattice is a regular repeating arrangement of points in space and forms the basis of classification of all structures.

29. (b) When an atom or an ion is missing from its normal lattice site, a lattice vacancy or defect is created, which is called Schottkey defect. Due to missing species, density of crystal will be lowered.

30. (b) On heating the metal atoms deposit on the surface and finally they diffuse into the crystal and after ionisation the alkali metal ion occupies cationic vacancy whereas electron occupies anionic vacancy.