**Useful for all Agricultural, Medical, Pharmacy and Engineering Entrance Examinations held across India.**

# MHT-CET
# Triumph Chemistry
## Based on Maharashtra Board Syllabus
# STD. XII Sci.

### Salient Features

- Exhaustive subtopic wise coverage of MCQs
- Quick review and/or important formulae provided for all the chapters
- Hints included for relevant questions
- Exhaustive coverage of various competitive exam questions
- Includes solved MCQs from MHT CET, JEE (Main), NEET (UG) 2015, 2016, 2017
- Evaluation test provided at the end of each chapter
- Includes two Model Question Papers with answers

*Solutions/hints to Evaluation Test available in downloadable PDF format at* ***www.targetpublications.org/tp12400***

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# *Preface*

**"Std. XII: Sci. Triumph Chemistry"** is a complete and thorough guide to prepare students for competitive level examinations. This book not only assists students with MCQs of Std. XII but also helps them to prepare for MHT CET, JEE, AIPMT/NEET (UG) and various other competitive examinations.

The content of this book is based on the Maharashtra State Board Syllabus. **Quick Review** which summarizes the important concepts of the entire chapter is provided for all the chapters. **Formulae** that form a vital part of MCQ solving are provided for relevant chapters. **Shortcuts** provide easy and less tedious solving methods.

MCQs in each chapter are divided into three sections:

**Classical Thinking**: consists of straight forward questions including knowledge based questions.

**Critical Thinking**: consists of questions that require understanding of the concept and the applications of the same.

**Competitive Thinking**: consists of questions from various competitive examinations like MHT CET, JEE, AIPMT/NEET-UG, AIIMS, AFMC, CPMT, Gujarat (GUJ CET), KCET, Assam CEE, BCECE, Telangana State (TS) EAMCET(Engineering, Medical), etc.

**Hints** (i.e., complete solutions broken down to the simplest form possible) have been provided to the MCQs.

An **Evaluation Test** has been provided at the end of each chapter to assess the level of preparation of the student on a competitive level.

In order to understand how chemistry plays an important role in our day to day life, we have made an attempt to illustrate the same in the form of images/visuals in the related chapters.

Now a days, multiple step reactions are frequently asked in Competitive Exams. Though the relevant chapters contain ample questions of such type, we have introduced an additional section of **Organic Reactions** which will help the students to check their grasp on these reactions.

Apart from this, two **Model Question Papers** (as per latest MHT CET pattern) are also provided for additional practice.

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.
Please write to us at : mail@targetpublications.org

*Best of luck to all the aspirants!*

Yours faithfully

Authors

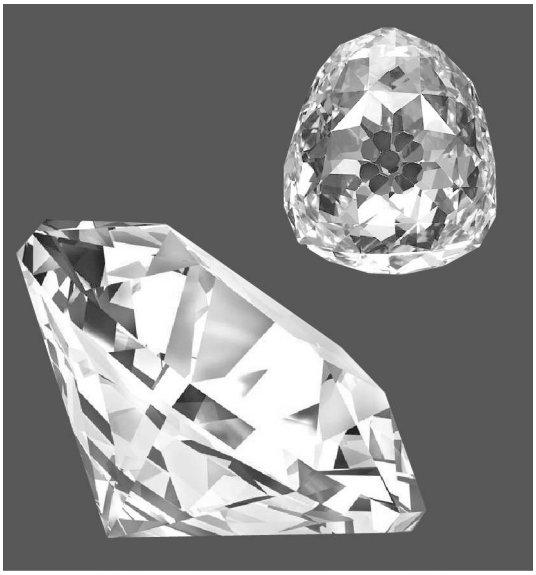
**Edition:** Second

# 01 Solid State

## *Subtopics*



***Valuable defective materials !!!!***



*Do all defective materials turn up discarded? Well .... think again. They might be present in your jewelleries studded with precious and semi-precious stones. These stones with eye-catching colour and shine are due to their crystalline structure with presence of trace quantities of mostly transition elements, which are generally called as impurities. One such example is corrundum ($Al_2O_3$) an important mineral of aluminium. The gemstone varieties of this mineral are ruby, sapphire, etc.*
*Ruby (Red) contains $Al_2O_3$ and $Cr_2O_3$*
*Sapphire (blue) contains $Al_2O_3$, $Fe_2O_3$ and $TiO_2$.*

## Quick Review

➢ **Classification of solids on the basis of the presence or absence of orderly arrangement of the constituent particles:**

**Solids**

**Crystalline**
A homogeneous solid in which the constituent particles are arranged in a definite geometric pattern.
**eg.** NaCl, MgO, etc.

**Amorphous**
Substances that appear like solids but do not have well developed perfectly ordered crystalline structure.
**eg.** Tar, glass, plastic, rubber, butter, etc.

➢ **Classification of crystalline solids based on different binding forces:**

**Crystalline Solids**

**Molecular solids**
Constituent particles are molecules of the same compound.

**Ionic solids**
Constituent particles are ionic molecules.
**eg.** NaCl, ZnS, CuCl

**Metallic solids**
Formed by atoms of the same metallic elements.
**eg.** Copper, gold

**Covalent solids**
Formed by chemical (covalent) bonds between the neighbouring constituent atoms of non-metallic solids.
**eg.** diamond, graphite and fullerene

**Polar molecular solids**
Constituent particles are covalently bonded molecules.
**eg.** HCl, $SO_2$ at low temperature and high pressure

**Non-polar molecular solids**
Constituent particles are non-polar molecules and weakly polar molecules.
**eg.** $CO_2$, $H_2$, $Cl_2$, $CH_4$ at very low temperatures

**Hydrogen bonded molecular solids**
Molecules are held together by hydrogen bonds.
**eg.** Solid ice

➢ **Seven crystal systems:**

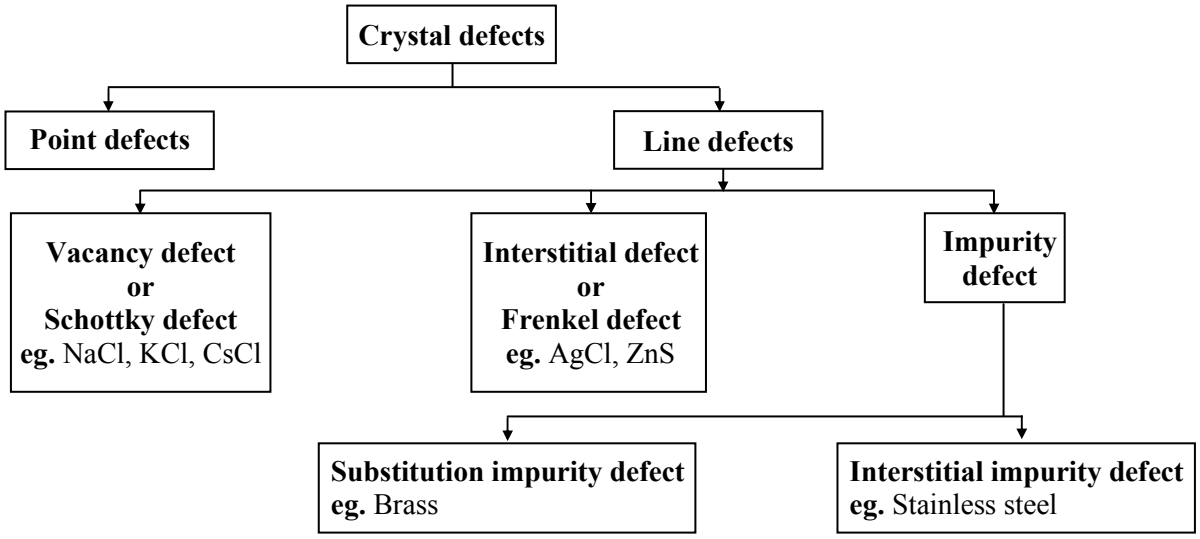
| No. | Crystal system | Type | Edge length | Angle | Examples |
|---|---|---|---|---|---|
| 1. | Cubic | Simple/primitive | a = b = c | $\alpha = \beta = \gamma = 90°$ | Polonium |
| 2. | Cubic | Body-centred | a = b = c | $\alpha = \beta = \gamma = 90°$ | Fe, Rb, Na, Ti, W, U, Zr |
| 3. | Cubic | Face-centred | a = b = c | $\alpha = \beta = \gamma = 90°$ | Cu, Al, Ni, Au, Ag, Pt |
| 4. | Tetragonal | Primitive | a = b ≠ c | $\alpha = \beta = \gamma = 90°$ | $SnO_2$ |
| 5. | Tetragonal | Body-centred | a = b ≠ c | $\alpha = \beta = \gamma = 90°$ | $TiO_2$, $CaSO_4$ |
| 6. | Orthorhombic | Primitive | a ≠ b ≠ c | $\alpha = \beta = \gamma = 90°$ | Rhombic sulphur |
| 7. | Orthorhombic | Body-centred | a ≠ b ≠ c | $\alpha = \beta = \gamma = 90°$ | $KNO_3$ |
| 8. | Orthorhombic | Face-centred | a ≠ b ≠ c | $\alpha = \beta = \gamma = 90°$ | $BaSO_4$ |
| 9. | Orthorhombic | End-centred | a ≠ b ≠ c | $\alpha = \beta = \gamma = 90°$ | $MgSO_4.\ 7H_2O$ |
| 10. | Monoclinic | Primitive | a ≠ b ≠ c | $\alpha = \beta = 90°, \gamma \neq 90°$ | Monoclinic sulphur |
| 11. | Monoclinic | End-centred | a ≠ b ≠ c | $\alpha = \beta = 90°, \gamma \neq 90°$ | $Na_2SO_4.\ 10H_2O$ |
| 12. | Triclinic | Primitive | a ≠ b ≠ c | $\alpha \neq \beta \neq \gamma \neq 90°$ | $K_2Cr_2O_7$, $H_3BO_3$ |
| 13. | Hexagonal | Primitive | a = b ≠ c | $\alpha = \beta = 90°, \gamma = 120°$ | ZnO, BeO, CoS, SnS |
| 14. | Rhombohedral | Primitive | a = b = c | $\alpha = \beta = \gamma \neq 90°$ | Calcite, $NaNO_3$, $FeCO_3$ |

➢ **Three types of cubic lattices:**

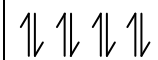
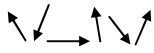
**Cubic lattice**

| **Simple** | **Body-centred** | **Face-centred** |
|---|---|---|
| Lattice points at eight corners of unit cell.<br>(1 particle per unit cell)<br>(52.4% occupied space)<br>**eg.** Polonium | Lattice points at eight corners and one at body centre of unit cell.<br>(2 particles per unit cell)<br>(68.04% occupied space)<br>**eg.** Fe, Na | Lattice points at eight corners and six face centres of unit cell.<br>(4 particles per unit cell)<br>(74.0 % occupied space)<br>**eg.** Cu, Al |

➢ **Types of defects in crystal structure:**




➢ **Classification of solids based on response to magnetic field:**

| Substance | Characteristics | Magnetic alignment | Examples | Application |
|---|---|---|---|---|
| Diamagnetic materials | • Repelled weakly in magnetic field.<br>• All electrons are paired. |  | Benzene, NaCl, $H_2O$ | Insulators |
| Paramagnetic materials | • Weakly attracted in magnetic field.<br>• Unpaired electrons are present.<br>• Permanent magnetisation is not possible. |  | $O_2$, $Cu^{2+}$, $Fe^{3+}$, $Cr^{3+}$ | Electronic devices |
| Ferromagnetic materials | • Strongly attracted in magnetic field.<br>• Unpaired electrons are present.<br>• Permanent magnetisation is possible. |  | Fe, Ni, Co, Gd, $CrO_2$ | $CrO_2$ is used in audio, video tapes. |

## Formulae

**1. Relationship between radius of atom (r) and edge length (a):**

| | |
|---|---|
| Simple cubic unit cell | $r = \frac{a}{2}$ |
| Body-centred cubic unit cell | $r = \frac{\sqrt{3}}{4}a$ |
| Face-centred cubic unit cell | $r = \frac{a}{2\sqrt{2}}$ |

**2. Relationship between the nearest neighbour distance (D) and edge length (a) of a cubic unit cell:**

| | |
|---|---|
| Simple cubic unit cell | D = edge length = a |
| Body-centred cubic unit cell | $D = \frac{1}{2} \times$ body diagonal $= \frac{\sqrt{3}}{2} a$ |
| Face-centred cubic unit cell | $D = \frac{1}{2} \times$ face diagonal $= \frac{a}{\sqrt{2}}$ |

**3. Density of unit cell:**

$$d = \frac{z.M}{a^3.N_0}$$

where, a is edge of unit cell

$N_0$ = Avogadro number ($6.023 \times 10^{23}$)

M = Molar mass, z = number of atoms per unit cell

For fcc, z = 4, for bcc, z = 2 and for simple cubic, z = 1

**4. Conversion factors:**

1 Å = $1 \times 10^{-8}$ cm = $1 \times 10^{-10}$ m = 100 pm

1 pm = $1 \times 10^{-10}$ cm

**5. Packing efficiency** = $\frac{\text{Volume occupied by spheres in unit cell}}{\text{Volume of unit cell}} \times 100$

**6. Radius rule and coordination number for ionic crystals:**

In simple ionic crystals, the cations commonly occupy the voids or holes. The voids are empty spaces left between anionic spheres.

**i. Radius Ratio $\left(\frac{r^+}{r^-}\right)$:**

The critical radius ratio of the void (cation) and sphere (anion), is calculated by solid geometry.

$\therefore$ Radius ratio = $\frac{r^+}{r^-} = \frac{\text{Cation radius}}{\text{Anion radius}}$

**ii. Coordination Number (CN):** The number of spheres (atoms, molecules or ions) directly surrounding a single sphere in a crystal, is called coordination number.

**7. Crystal structures of some elements and their coordination numbers (CN):**

| Crystal structure | Examples | Coordination No. |
|---|---|---|
| bcc | Fe, Na, Ti, Rb, W, U, Zr | 8 |
| fcc or ccp | Al, Ni, Cu, Ag, Au, Pt | 12 |

**8. Relation between radius ratio, coordination number and geometry:**

| Radius ratio $\left(\frac{r^+}{r^-}\right)$ | Coordination number | Geometry | Examples |
|---|---|---|---|
| 0.155 to 0.225 | 3 | Planar triangular | $B_2O_3$ |
| 0.225 to 0.414 | 4 | Tetrahedral | ZnS |
| 0.414 to 0.732 | 6 | Octahedral | NaCl |
| 0.732 to 1.0 | 8 | Cubic | CsCl |

## Classical Thinking

### 1.0 Introduction

1. Which among the following solids is NOT soft?
   (A) Sodium (B) Potassium
   (C) Copper (D) Phosphorus

### 1.1 Classification of solids

2. Graphite, diamond and fullerene are the polymorphic forms of _____.
   (A) sulphur
   (B) carbon
   (C) calcium carbonate
   (D) silicon dioxide

3. The ability of crystalline solids to change values of physical properties when measured in different directions is called _____.
   (A) polymorphism (B) isomorphism
   (C) anisotropy (D) isotropy

4. A solid having irregular shape is called _____ solid.
   (A) amorphous
   (B) crystalline
   (C) anisotropic
   (D) isomorphous

5. Amorphous solids _____.
   (A) possess sharp melting points
   (B) exhibit anisotropy
   (C) do not undergo clean cleavage when cut with knife
   (D) possess orderly arrangement over long distances

6. Amorphous substances have _____.
   (i) definite heat of fusion
   (ii) only short range order
   (iii) only long range order
   (iv) indefinite heat of fusion

   (A) (i) and (iii) are correct
   (B) (ii) and (iii) are correct
   (C) (iii) and (iv) are correct
   (D) (ii) and (iv) are correct

7. Amorphous solids are _____.
   (A) true solid substances
   (B) substances with ordered internal structure
   (C) super cooled liquids
   (D) substances with definite melting point

8. Which of the following is a crystalline solid?
   (A) Glass (B) Rubber
   (C) Plastic (D) Sugar

9. Glass is a _____.
   (A) supercooled liquid
   (B) crystalline solid
   (C) non-crystalline solid
   (D) liquid crystal

10. Yellow glass contains _____.
    (A) CuO (B) $UO_2$
    (C) CoO (D) $Fe_2O_3$

### 1.2 Classification of crystalline solids

11. The molecules of polar molecular solids are held together by _____.
    (A) dipole-dipole interactions
    (B) London dispersion forces
    (C) hydrogen bonds
    (D) covalent bonds

12. Which of the following is a hydrogen bonded molecular crystal?
    (A) HCl (B) $H_2$
    (C) $CH_4$ (D) Ice

13. In ionic solids, the arrangement of ions depends on _____.
    (A) sizes of cations and anions
    (B) the charges on the ions
    (C) polarisability of anion
    (D) all of these

14. ZnS is a / an _____ crystal.
    (A) ionic (B) covalent
    (C) metallic (D) molecular

15. A sea of electrons is present in _____ solids.
    (A) ionic
    (B) metallic
    (C) non-polar molecular
    (D) polar molecular

16. Which of the following is an example of metallic crystal solid?
    (A) C (B) Si
    (C) W (D) AgCl

17. Crystals of covalent compounds always have _____.
    (A) atoms as their structural units
    (B) molecules as structural units
    (C) ions held together by electrostatic forces
    (D) high melting points

18. _____ solids are also called giant solids or network solids.
(A) Covalent (B) Molecular
(C) Ionic (D) Metallic

19. In graphite, carbon atoms form interlinked _____ membered rings.
(A) four (B) five
(C) six (D) seven

20. In diamond and graphite, the hybridizations of carbon atoms are _____ respectively.
(A) sp, $sp^2$ (B) $sp^3$, $sp^2$
(C) $sp^3$, sp (D) $sp^2$, $sp^3$

21. In $C_{60}$, carbon atoms form _____.
(A) hexagons and octagons
(B) pentagons and triangles
(C) hexagons and pentagons
(D) squares and quadrilaterals

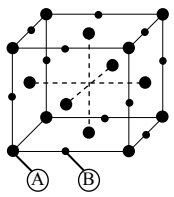
## 1.3 Unit cell, two and three dimensional lattices and number of atoms per unit cell

22. Crystals can be classified into _____ basic crystal units.
(A) 3 (B) 7
(C) 14 (D) 4

23. Bravais lattices are of _____ types.
(A) 8 (B) 12
(C) 14 (D) 9

24. Which of the following are the CORRECT axial distances and axial angles for rhombohedral system?
(A) $a = b = c$, $\alpha = \beta = \gamma \neq 90°$
(B) $a = b \neq c$, $\alpha = \beta = \gamma = 90°$
(C) $a \neq b \neq c$, $\alpha = \beta = \gamma = 90°$
(D) $a \neq b \neq c$, $\alpha \neq \beta \neq \gamma \neq 90°$

25. For a solid with the structure as shown in the figure, the coordination number of the point B is _____.
(A) 3
(B) 4
(C) 5
(D) 6




26. The number of atoms or molecules contained in one primitive cubic unit cell is _____.
(A) 1 (B) 2
(C) 4 (D) 6

## 1.4 Packing in solids

27. In two dimensional ABAB type arrangement, the coordination number of each sphere is _____.
(A) 2 (B) 4
(C) 6 (D) 12

28. In planar square close packing, each sphere is surrounded by _____.
(A) six triangular holes
(B) four square shaped holes
(C) six square shaped holes
(D) four tetrahedral holes

29. In a close pack array of N spheres, the number of tetrahedral holes is _____.
(A) 4N (B) N/2
(C) 2N (D) N

30. The number of tetrahedral voids in a unit cell of cubical closest packed structure is _____.
(A) 1 (B) 2
(C) 4 (D) 8

31. In octahedral voids, _____.
(A) a simple triangular void is surrounded by four spheres
(B) a bi-triangular void is surrounded by four spheres .
(C) a bi-triangular void is surrounded by six spheres
(D) a bi-triangular void is surrounded by eight spheres

32. In hcp arrangement, the number of nearest neighbours is _____.
(A) 10 (B) 7
(C) 2 (D) 12

## 1.5 Density of unit cell

33. The packing efficiency in simple cubic unit cell is _____.
(A) 52.4% (B) 68.04%
(C) 74% (D) 80%

34. The space occupied by bcc arrangement is approximately _____.
(A) 50% (B) 68%
(C) 74% (D) 56%

35. The maximum percentage of available volume that can be filled in a face-centred cubic system by an atom is _____.
(A) 74% (B) 68%
(C) 34% (D) 26%