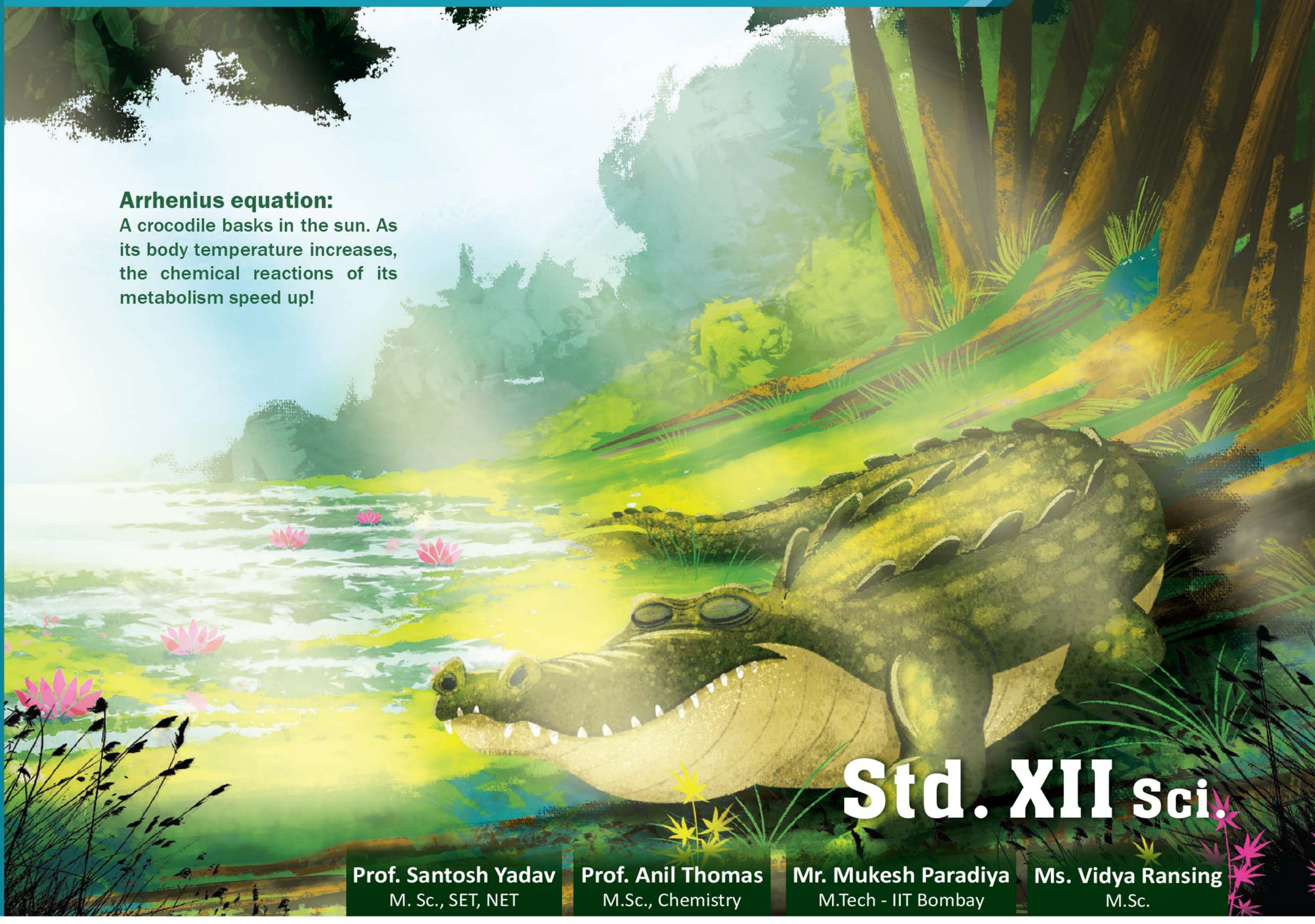
SAMPLE CONTENT

PERFECT

CHEMISTRY

Vol. I

Based on Latest Paper Pattern and Textbook



Arrhenius equation:
A crocodile basks in the sun. As its body temperature increases, the chemical reactions of its metabolism speed up!

Std. XII Sci.

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PERFECT

CHEMISTRY (Vol. I)

Std. XII Sci.

Salient Features

- Written as per **Latest Board Paper Pattern**
- Subtopic-wise segregation for powerful concept building
- Complete coverage of Textual Exercise Questions, Intext Questions and Numericals
- Marks provided to the Questions as per relevant weightage wherever deemed necessary
- Relevant Previous Years' Board Questions: **March 2013 to July 2023**
- Each chapter contains:
  - 'Quick Review' of the chapter for quick revision
  - 'Apply Your Knowledge' section for application of concepts
  - 'Important Formulae' and 'Solved Examples' to cover numerical aspect in detail
  - 'Exercise' to provide Theory questions, Numericals and MCQs for practice
  - 'Competitive Corner' to give the glimpse of prominent competitive examinations
  - 'Topic Test' at the end of each chapter for self-assessment
- Includes Important Features for holistic learning:
  - ***About the Chapter***
  - ***Reading Between the Lines***
  - ***NCERT Corner***
  - ***Enrich Your Knowledge***
  - ***Gyan Guru***
  - ***Strategy***
  - ***Connections***
  - ***Caution***
- Q.R. codes provide:
  - The Video/pdf links boosting conceptual retention
  - Solutions of Numericals for Practice and Topic Tests
  - Model Question Paper along with Solution

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PREFACE

Perfect Chemistry Vol. I, Std. XII Sci. is intended for every Maharashtra State Board aspirant of Std. XII, Science. The scope, sequence, and level of the book consistent with the latest textbook released by Maharashtra State board.

At this crucial juncture in their lives, when the students are grappling with the pressures of cracking a career-defining board examination, we wanted to create a book that not only develops the necessary knowledge, tools, and skills required to excel in the examination, but also enables students to appreciate the beauty of the subject and piques their curiosity.

We believe that students respond favourably to meaningful content, if it is presented in a way that is easy to read and understand, rather than being mired down with facts and information. Consequently, we have always placed the highest priority on writing clear and lucid explanations of fundamental concepts. Moreover, special care has been taken to ensure that the topics are presented in a logical order. The coherent Question/Answer approach helps students expand their horizon of understanding of the concepts.

The primary purpose of this book is to assist the students in preparing for the board examination. However, this is closely linked to other goals: to exemplify how important and how incredibly interesting chemistry is, and to help the student become an expert thinker and problem solver.

Solving numericals is essential for success in chemistry!

To help the students hone their problem-solving skills, this book amalgamates numericals that are rich in both variety and number which provides the student with ample practice, ensuring mastery of each concept.

Every chapter in this book begins with ***'About the Chapter'*** that offers a brief introduction of the chapter and orients students towards the topic from examination point of view. The scope of the book extends beyond the State Board examination as it also offers a plethora of Multiple Choice Questions (MCQs) in order to familiarize the students with the pattern of competitive examinations.

In addition, the Topic Tests have been carefully crafted to focus on concepts, thus providing the students with a quick opportunity for self-assessment and giving them an increased appreciation of chapter-preparedness. '***Model Question Paper'*** based on latest paper pattern is provided along with solution through QR code to help students assess their preparedness for final board examination.

We believe that the study of chemistry helps in the understanding of many fascinating and important phenomena. In this vein, we have put an effort to relate chemistry to real-world events in order to show students that chemistry is a vibrant, constantly evolving science that has relevance in our modern world. We hope this book becomes a valuable tool for you and helps you to not only understand the concepts of chemistry but also to see the world from a molecular point of view.

Our **Perfect Chemistry Vol. I, Std. XII Sci.** adheres to our vision and achieves several goals: **building concepts**, **developing competence to solve numerical, recapitulation, self-study, self-assessment** and **student engagement**—all while encouraging students toward cognitive thinking.

Publisher

Edition: Sixth

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 on: mail@targetpublications.org

KEY FEATURES

About the chapter

'About the Chapter' is a short introduction designed to stimulate students' appetite for the topic.

Reading between the lines

Reading between the lines provides elaboration or missing fragments of concept which is essential for complete understanding of the concept.

NCERT Corner

NCERT Corner covers information from NCERT textbook relevant to topic.

Connections

Connections enable students to interlink concepts covered in different chapters.

Caution

Caution helps students to be watchful against commonly made mistakes.

Strategy

Strategy provides a step-by-step process to break a complex numerical problem into simpler parts.

QR Codes

QR code provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity
ii. Solutions of Numericals for Practice
iii. Solutions to the Topic Tests
iv. Model Question Paper with solution

Enrich Your Knowledge

Enrich Your Knowledge presents fascinating information about the concept covered.

Continued…

KEY FEATURES

GG-Gyan Guru

Gyan Guru illustrates real life applications or examples related to the concept discussed.

Apply Your Knowledge

Apply Your Knowledge includes challenging questions.

Quick Review

Quick review includes tables/ flow chart to summarize the key points in chapter.

Important Formulae

Important Formulae includes all of the key formulae in the chapter.

Competitive Corner

Competitive Corner includes selective questions from prominent [NEET (UG), JEE (Main), MHT CET] competitive exams based entirely on the syllabus covered in the chapter.

Board Questions

Includes relevant Board questions from March 2013 to July 2023

PAPER PATTERN

- There will be single question paper of 70 Marks and practical examination of 30 Marks in Chemistry.
- Duration of the question paper will be 3 hours.

Section A: **(18 Marks)**

This section will contain Multiple Choice Questions and Very Short Answer(VSA) type of questions.
There will be 10 MCQs and 8 VSA type of questions, each carrying **One** mark.
Students will have to attempt all the questions.

Section B: **(16 Marks)**

This section will contain 12 Short Answer (SA-I) type of questions, each carrying **Two** marks.
Students will have to attempt any 8 questions.

Section C: **(24 Marks)**

This section will contain 12 Short Answer (SA-II) type of questions, each carrying **Three** marks.
Students will have to attempt any 8 questions.

Section D: **(12 Marks)**

This section will contain 5 Long Answer (LA) type of questions, each carrying **Four** marks.
Students will have to attempt any 3 questions.

Distribution of Marks According to the Type of Questions

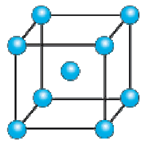
Type of Questions		
MCQ	1 Mark each	10 Marks
VSA	1 Mark each	8 Marks
SA - I	2 Marks each	16 Marks
SA - II	3 Marks each	24 Marks
LA	4 Marks each	12 Marks

CONTENTS

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04**]**

Note: 1. * mark represents Textual Exercise question.
2. # mark represents Intext question.
3. + mark represents Textual examples.
4. symbol represents textual questions that need external reference for an answer.
5. Chapters 10 to 16 are a part of Perfect Chemistry Vol. II, Std. XII Sci.

1 Solid State



About the chapter…

This chapter introduces students to the types, structures, defects and properties of solids through a blend of theoretical questions and numericals. Chapter gives special focus to diagrams such as cubic unit cells, packing of particles and crystal defects.

Chapter weightage is 5 marks with option and 3 marks without option in the board examination.

CONTENTS AND CONCEPTS

1.1 Introduction

Q.1. Can you recall? *(Textbook page no. 1)*

i. What are the three most common states of matter? **[1 Mark]**

ii. How does solid state differ from the other two states? (Answer with reference to volume, shape, effect of temperature and pressure on these and the motion of constituent particles and interparticle forces.) **[3 Marks]**

Ans:

i. The three most common states of matter are:

a. Solid b. Liquid c. Gas

ii.

No.	Points	Solid	Liquid	Gas
a.	Volume	Has definite volume	Has definite volume	Takes the volume of its container
b.	Shape	Has definite shape	Takes the shape of its container	Takes the shape of its container
c.	Effect of a small change in temperature	Volume change is small	Moderate effect on volume change	Volume change is significantly high.
d.	Effect of pressure	Practically non-compressible	Small compressibility	Compressible
e.	Movement of constituent particles	Particles cannot move freely as they occupy fixed positions.	Particles can move a small distance within the liquid	Particles are in continuous random motion.
f.	Interparticle forces	Strong	Less strong	Very weak

Q.2. What are the smallest constituent particles of various solids? **[1 Mark]**

Ans: The smallest constituent particles of various solids are atoms, molecules or ions.

1.2 Types of solids

Q.3. What are the two types of solids? **[1 Mark]**

Ans: The two types of solids are:

i. Crystalline solids ii. Amorphous solids

Q.4. Observe and discuss. *(Textbook page no. 1)*

i. Collect the following solids: granular sugar, common salt, blue vitriol.
Observe a few granules of these solids under a magnifying lens or microscope.
Discuss your observations with reference to the following points:

a. Shape of the granules,
b. Smoothness of faces of the granules and
c. Angles between various edges of the granules.

ii. All the above solids are crystalline solids. Name the properties of crystals that you observed in this activity.

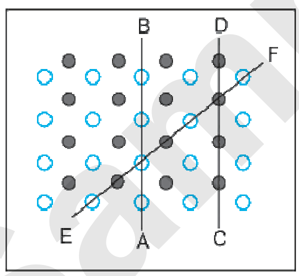
[2 Marks]

Ans:

i. a. All the granules of a particular solid have the same shape.
The shape of the salt granules appears cube-like, while sugar granules are slightly oblong and edges are slanting. Granules of blue vitriol have triclinic shape.
b. The faces of granules are plain and smooth.
c. The angles between the various edges of the granules are same in each granule of the particular solid.

ii. Each granule has a definite characteristic geometrical shape.

Q.5. Try this *(Textbook page no. 1)*
Observe the figure carefully. The two types of circles in this figure represent two types of constituent particles of a solid.



i. Will you call the arrangement of particles in this solid regular or irregular?

ii. Is the arrangement of constituent particles same or different in directions $\overrightarrow{AB}$, $\overrightarrow{CD}$, and $\overrightarrow{EF}$?

[2 Marks]

Ans:

i. The arrangement of particles in the given solid is regular.

ii. The arrangement of particles in the direction $\overrightarrow{AB}$ and $\overrightarrow{CD}$ is same as both these lines pass through same type of particles. The arrangement of particles in the direction $\overrightarrow{EF}$ is different as this line pass through different type of particles.

Q.6. State the properties of crystalline solids.

[2 Marks]

Ans: Crystalline solids possess the following characteristic properties:

i. There is a regularity and periodicity in the arrangement of constituent particles in crystalline solids.

ii The ordered arrangement of particles extends over a long range.

iii. Crystalline solids have sharp melting points, that is, they melt at a definite temperature.

iv. All crystalline substances except those having cubic structure are anisotropic. In other words, their properties like refractive index, thermal and electrical conductivity, etc., are different in different directions.

Q.7. Give four examples of crystalline solids.

[2 Marks]

Ans: Examples of crystalline solids: Ice, NaCl, copper, diamond

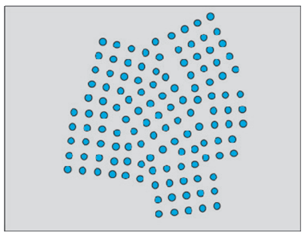
ENRICH YOUR KNOWLEDGE

Do You Know? *(Textbook page no. 2)*

i. A single crystal has ordered (regular and periodic) arrangement of constituent particles throughout its bulk.

ii. Majority of crystalline solids, including metals, are polycrystalline in nature. Single granule of a polycrystalline solid is made of many single crystals or crystallites packed together with different orientations.

iii. Single crystals are difficult to obtain. Diamond is an example of naturally formed single crystal.



Q.8. Write the properties of amorphous solids.

[2 Marks]

Ans: Amorphous solids have the following characteristics properties:

i. The constituent particles in amorphous solids are randomly arranged.

ii. The particles do not have long range ordered structure, but they do have a short range order.

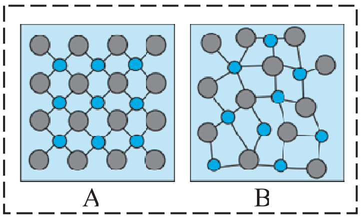
iii. Amorphous solids do not have sharp melting points. They melt gradually over a temperature interval. On heating, amorphous solids gradually and continuously soften and start to flow.

iv. Amorphous solids are isotropic. That is, their properties such as refractive index, conductivity are all independent of direction of measurement. They exhibit the same magnitude for any property in every direction.

Q.9. Give four examples of amorphous solids. **[2 Marks]**

Ans: Examples of amorphous solids: Glass, plastic, metallic glass (metal-metalloid alloy), tar.

Q.10. Use your brain power *(Textbook page no. 2)*
Identify the arrangements A and B as crystalline or amorphous. **[1 Mark]**



Ans: Arrangement A represents crystalline solids.
Arrangement B represents amorphous solids.

Q.11. Distinguish between crystalline solids and amorphous solids. **[2 Marks]** **[Mar 13, 14, 17, 19]**

Ans:

	Crystalline solids	Amorphous solids
i.	The constituent particles are arranged in a regular and periodic manner.	The constituent particles are arranged randomly.
ii.	They have sharp and characteristic melting point.	They do not have sharp melting point. They gradually soften over a range of temperature.
iii.	They are anisotropic, i.e., have different physical properties in different direction.	They are isotropic, i.e., have same physical properties in all directions.
iv.	They have long range order.	They have only short range order.
e.g.	Ice, NaCl, etc.	Glass, rubber, plastics, etc.

Q.12. Define **[1 Mark each]**
i. Isomorphism **[July 23]**
ii. Polymorphism

Ans:

i. Isomorphism is the phenomenon by which two or more substances have the same crystal structure.

ii. Polymorphism is the phenomenon by which a single substance exists in two or more forms or crystalline structures.

Q.13. Explain the terms with examples:
i. Isomorphous **[2 Marks]**
ii. Polymorphous **[2 Marks]**

Ans:

i. *Two or more substances having the same crystal structure are said to be* ***isomorphous****.*
In these substances, the chemical composition has the same atomic ratio.
For example, (i) NaF and MgO (ii) $NaNO_3$ and $CaCO_3$ are isomorphous pairs, and have the same atomic ratios, 1:1 and 1:1:3, respectively, of the constituent atoms.

ii. *A single substance that exists in two or more forms or crystalline structures is said to be* ***polymorphous****.*
Polymorphs of a substance are formed under different conditions.
For example, Calcite and aragonite are two forms of calcium carbonate; α-quartz, β-quartz and cristobalite are three of the several forms of silica.

Q.14. What is meant by the term 'allotropy'? **[1 Mark]**

Ans: *Polymorphism occurring in elements is called* ***allotropy****.*
e.g. Diamond, graphite and fullerene are allotropic forms of carbon.

ENRICH YOUR KNOWLEDGE

Do You Know? *(Textbook page no. 3)*
Many crystalline forms of silica (SiO_2) are found in nature. Three of them are α-quartz, β-quartz and cristobalite.

1.3 Classification of crystalline solids

Q.15. What are the four main classes of crystalline solids? **OR**
Give the classification of crystalline solids. **[2 Marks]**

Ans: The four main classes of crystalline solids are:
i. Ionic solids
ii. Covalent network solids
iii. Molecular solids
iv. Metallic solids

Q.16. What are the characteristics of ionic crystals? **[2 Marks]**

Ans: **Characteristics of ionic crystals:**

i. The constituent particles of ionic crystals are charged ions. The cations and anions may differ in size.

ii. Each ion of a given sign of charge is bonded to ions of opposite charge around it by coulombic force. That is, the particles of ionic crystals are held by electrostatic force of attraction between oppositely charged ions.

iii. Ionic crystals are hard and brittle. They have high melting points.

iv. These are nonconductors of electricity in solid state. However, they are good conductors when melted or dissolved in water.

Q.17. Ionic solids conduct electricity in molten state but not in solid state. Give reason. [2 Marks]

Ans:

i. In ionic solids, constituent ions are held together by strong electrostatic forces of attraction and they are present in fixed position in crystal lattice. Therefore, they cannot move when an electric field is applied.

ii. However, in molten state the well-defined arrangement of ions in the crystal is destroyed and the ions can move freely when electric field is applied.

Hence, ionic solids conduct electricity in molten state.

Q.18. What are the characteristics of covalent network crystals? [2 Marks]

Ans: Characteristics of covalent network crystals:

i. The constituent particles in covalent network solids are atoms.

ii. The atoms in these crystals are linked by a continuous system of covalent bonds. The result is a rigid three dimensional network that forms a giant molecule. The entire crystal is a single molecule.

iii. As a result of rigid and strongly bonded structure, covalent network crystals are very hard. They are the hardest and most incompressible of all the materials. They have high melting and boiling points.

iv. The electrons are localised in covalent bonds and hence are not mobile. As a result, covalent solids are poor conductors of heat and electricity.

ENRICH YOUR KNOWLEDGE

Do You Know? *(Textbook page no. 3)*

Diamond is the hardest known material.

Q.19. Try this *(Textbook page no. 3)*

Graphite is a covalent solid yet soft and good conductor of electricity. Explain. [2 Marks]

Ans:

i. In graphite, each carbon atom is bonded to three other neighbouring carbon atoms by covalent bonds such that a hexagonal layered structure is formed.

ii. Each graphite crystal is made up of many sheets or layers of carbon atoms. These layers are held together by weak van der Waals forces and hence, these layers slip over each other on applying pressure making graphite very soft and slippery.

iii. The electrons in graphite are delocalized over the whole sheet. Due to the presence of mobile electrons, graphite is a good conductor of electricity.

Q.20. Can you recall? *(Textbook page no. 3)*

i. What are structures of diamond and graphite? [2 Marks]

ii. What are the types of covalent bonds those link carbon atoms in diamond and graphite? [2 Marks]

iii. Are all the valence electrons of carbon atoms in graphite localized to specific covalent bonds? [1 Mark]

Ans:

i. Diamond has three dimensional network of sp^3 hybridized carbon atoms joined by extended covalent bonds. Graphite has two dimensional sheet-like structure. Each layer of hexagonal rings is formed from sp^2 hybridized carbon atoms. These layers are held by weak van der Waals forces.

ii. In diamond, each carbon atom undergoes **sp^3 hybridization** and is linked to four other carbon atoms by using hybridized orbitals in tetrahedral fashion.

In graphite, each carbon atom in hexagonal ring undergoes **sp^2 hybridization** and makes three sigma bonds with three neighbouring carbon atoms. Fourth electron forms a π-bond.

iii. In graphite, the fourth electron forms a π-bond. Thus, the electrons are delocalised over the whole sheet.

Q.21. What type of solids are called supercooled liquids? [1 Mark]

Ans: Amorphous solids are called supercooled liquids.

Q.22. State the properties of molecular crystals. [2 Marks]

Ans: Properties of molecular crystals:

i. The constituent particles of molecular solids are molecules (or unbonded single atoms) of the same substance.

ii. The bonds within the molecules are covalent. The molecules are held together by various intermolecular forces of attraction such as weak dipole-dipole interactions, very weak dispersion or London forces and intermolecular hydrogen bonds.

iii. Molecular solids are usually soft substances with low melting points. This is because of weak intermolecular attractive forces.

iv. These solids are poor electrical conductors and are good insulators.

Q.23. Can you recall? *(Textbook page no. 4)*
What is a hydrogen bond? **[1 Mark]**

Ans: *The electrostatic force of attraction between positively polarized hydrogen atom of one molecule and a highly electronegative atom (which may be negatively charged) of other molecule is called as* ***hydrogen bond****.*

Q.24. What are the various types of intermolecular forces of attraction that hold molecules of molecular crystal together? **[3 Marks]**

Ans: The various types of intermolecular forces of attraction that hold molecules of molecular crystal together are:

i. **Weak dipole-dipole interactions** in polar molecules such as solid HCl, H_2O, SO_2, etc. which possess permanent dipole moment.

ii. **Very weak dispersion** or **London forces** in nonpolar molecules such as solid CH_4, H_2, etc. These forces are also involved in monoatomic solids like argon, neon. (These substances are usually gases at room temperature.)

iii. **Intermolecular hydrogen bonds** in solids such as H_2O (ice), NH_3, HF, etc.

Connections

You have studied in Std. XI, chapter 10: States of Matter: Gaseous and Liquid States about various intermolecular forces.

*Q.25. **Distinguish between ionic solids and molecular solids.** **[2 Marks]**

Ans: Differences between ionic solids and molecular solids:

No.	Ionic solids	Molecular solids
i.	The constituent particles are charged ions (cations and anions).	The constituent particles are monoatomic or polyatomic molecules.
ii.	The constituent particles are held by electrostatic force of attraction between oppositely charged ions.	The constituent particles are held by intermolecular forces of attractions such as London forces, dipole-dipole forces and/or hydrogen bonds.
iii.	They are hard and brittle.	They are soft.
iv.	They have high melting points.	They have low melting points.
v.	They are nonconductors of electricity in solid state. However, they are good conductors when melted or dissolved in water.	They are poor conductors of electricity.
e.g.	NaCl, CaF_2, etc.	Ice, benzoic acid, etc.

(Any four points)

Q.26. Write a note on metallic crystals. **[3 Marks]**

Ans:

i. Metallic crystals are crystalline solids formed by atoms of the same metallic element, held together by a metallic bond.
e.g. Metals such as Na, K, Ca, Li, Fe, Au, Ag, Co, etc.

ii. In a solid metal, the valence electrons are delocalised over the entire crystal leaving behind positively charged metal ions. Therefore, metallic crystals are considered as an array of positive ions immersed in a sea of mobile electrons.

iii. The attractive interactions between cations and mobile electrons constitute the metallic bonds.

iv. Metallic crystals have the following properties:

a. Metals are malleable, that is, they can be hammered into thin sheets.

b. Metals are ductile, that is, they can be drawn into wires.

c. Metals have good electrical and thermal conductivity.

*Q.27. **What are the types of particles in each of the four main classes of crystalline solids?** **[2 Marks]**

Ans: The types of particles in each of the four main classes of crystalline solids are:

i. Ionic solids: Constituent particles are cations and anions.

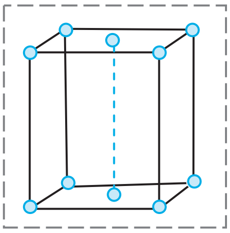
ii. Covalent network solids: Constituent particles are atoms.

iii. Molecular solids: Constituent particles are monoatomic or polyatomic molecules.

iv. Metallic solids: Constituent particles are metallic ions in a sea of electrons.

APPLY YOUR KNOWLEDGE

Q.138. What will be the number of atoms present per unit cell in following base-centred orthorhombic unit cell?



Ans:

i. In base-centred cubic unit cell, eight constituent particles (spheres) are present at eight corners of unit cell and two particles (spheres) are present at base-centre of unit cell.

ii. A constituent particle present at a corner is shared by eight neighbouring unit cells. Its contribution to a unit cell is only 1/8.

Thus, the number of atoms present at the corners per unit cell = 8 corner atoms × 1/8 atom per unit cell = 1

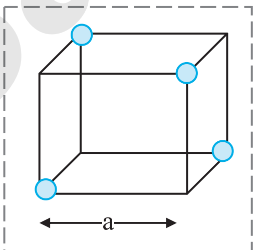
iii. The constituent particle present at the base-centre is shared by two neighbouring unit cells. Its contribution to unit cell is only 1/2.

Thus, the number of atoms present at base-centre per unit cell = 2 atoms at the base-centre × 1/2 atom per unit cell = 1

iv. The total number of atoms per unit cell = 1 + 1 = 2

Thus, a base-centred orthorhombic unit cell has 2 atoms per unit cell.

Q.139. Consider the given cubic unit cell (open structure) obtained from simple cubic unit cell by removing four diagonally opposite atoms. If 'a' is the edge length and 'r' is the radius of each atom, then



i. Calculate the packing efficiency of the above unit cell.

ii. Will the packing efficiency of above unit cell will be greater or less than the packing efficiency of simple cubic unit cell?

Ans:

i. Calculating packing efficiency:

a. In the given unit cell, atoms are located only at the alternate corners of the cube.

b. The four constituent atoms (at the corners) are shared by eight cubic unit cells. Therefore, the number of atoms per unit cell:

$= 4 \text{ corner atoms} \times \frac{1}{8} \text{ atom per unit cell}$

$= \frac{1}{2} \text{ atom}$

c. Volume of cubic unit cell = $a^3 = (2r)^3 = 8r^3$

d. Since the volume occupied by one spherical atom = $\frac{4}{3}\pi r^3$

Therefore, the volume occupied by $\frac{1}{2}$ spherical atom = $\frac{4}{3}\pi r^3 \times \frac{1}{2} = \frac{2}{3}\pi r^3$

e. Packing efficiency

$$= \frac{\text{volume occupied by atom in unit cell}}{\text{volume of cubic unit cell}} \times 100\%$$

$$= \frac{\frac{2}{3}\pi r^3}{8r^3} \times 100$$

$$= \frac{\pi}{12} \times 100$$

$= \mathbf{26.16\ \%}$

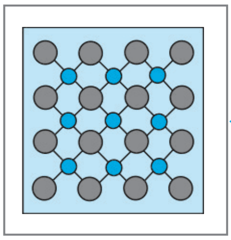
f. Thus, packing efficiency of the given cubic unit cell is **26.16%**

ii. The packing efficiency of simple cubic unit cell is 52.4 % whereas the packing efficiency of above given unit cell is 26.16 %. Therefore, packing efficiency of given cubic unit cell is less than packing efficiency of simple cubic unit cell.

QUICK REVIEW

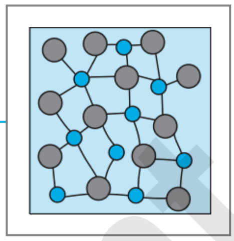
➤ **Classification of solids:**

Solids



Crystalline solids
- **e.g.** NaCl, Fe
- Regular arrangement of constituent particles
- Shows anisotropy

Amorphous solids
- **e.g.** Glass, Rubber
- Random arrangement of constituent particles
- Shows isotropy



➤ **Classification of crystalline solids:**

Crystalline solids

Ionic solids	**Covalent network solids**	**Molecular solids**	**Metallic solids**
e.g. NaCl, $CuSO_4$	**e.g.** SiO_2, Diamond	**e.g.** CO_2, Ice	**e.g.** Na, Fe

➤ **Packing in solids:**

Close packing of spheres

Linear packing in one dimension
In this arrangement, the spheres are placed in a horizontal row touching each other.
→ Coordination number = 2

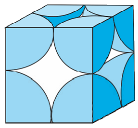
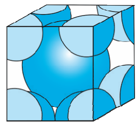
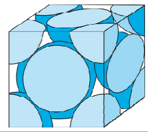
Planar packing in two dimensions

- **AAAA type**, square close packed structure
  In this arrangement, several linear one dimensional identical rows are placed one over the other in such a way that they have horizontal and vertical alignment.
  → Coordination number = 4
- **ABAB type**, hexagonal close packed structure
  In this arrangement, several linear one dimensional identical rows are placed one over the other in such a way that alternate rows (i.e., first and third row) have horizontal and vertical alignment.
  → Coordination number = 6

Close packing in three dimensions

- **AAAA type**, simple cubic structure
  In this arrangement, several layers of two dimensional square close packed structures are placed one above the other in such a way that they have horizontal and vertical alignment.
  → Coordination number = 6
- **ABAB type**, hexagonal close packed (hcp) structure
  In this arrangement, several layers of two dimensional hexagonal close packed structures are placed one above the other in such a way that alternate layers (i.e., first and third row) have horizontal and vertical alignment.
  Here, spheres of third layer are placed into the tetrahedral voids.
  e.g. Metals such as magnesium, zinc, etc.
  → Coordination number = 12
- **ABCABC type**, cubic close packed (ccp) or face-centred cubic (fcc) structure
  In this arrangement, several layers of two dimensional hexagonal close packed structures are placed one above the other in such a way that first and fourth layer have horizontal and vertical alignment.
  Here, spheres of third layer are placed into the octahedral voids.
  e.g. Metals such as copper, silver, etc.
  → Coordination number = 12

➢ Types of cubic unit cell:

Type of unit cell	Simple cubic	Body-centred cubic	Face-centred cubic
Diagram			
No. of particles per unit cell	**1**	**2**	**4**
Relation between a and r	$r = \frac{a}{2} = 0.5000\ a$	$r = \frac{\sqrt{3}}{4}a = 0.4330\ a$	$r = \frac{\sqrt{2}}{4}a = 0.3535\ a$
Volume of one particle	$\frac{\pi a^3}{6} = 0.5237\ a^3$	$\frac{\sqrt{3}\pi a^3}{16} = 0.34\ a^3$	$\frac{\pi a^3}{12\sqrt{2}} = 0.185\ a^3$
Total volume occupied by particles in unit cell	$\frac{\pi a^3}{6} = 0.5237\ a^3$	$\frac{\sqrt{3}\pi a^3}{8} = 0.68\ a^3$	$\frac{\pi a^3}{3\sqrt{2}} = 0.74\ a^3$
Coordination number of atoms	**6** : four in the same layer, one directly above and one directly below	**8** : four in the layer below and four in the layer above	**12** : six in its own layer, three above and three below
Packing efficiency	**52.4 %**	**68 %**	**74 %**

➢ Crystal defects:

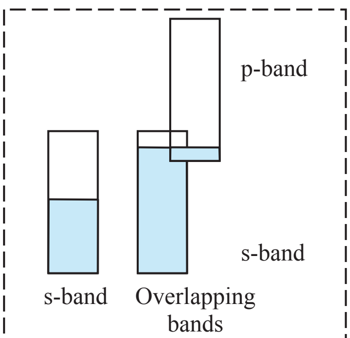
- **Crystal defects**
  - **Point defects**
    - Stoichiometric defects
      - Interstitial defect
      - Vacancy defect
      - Schottky defect
      - Frenkel defect
    - Impurity defects
      - Substitutional impurity defect
      - Interstitial impurity defect
    - Non-stoichiometric defects
      - Metal deficiency defect
      - Metal excess defect
  - **Line defects**

➢ Classification of solids based on electrical properties:

- **Solids**
  - **Metallic conductors**
  - **Insulators**
  - **Semiconductors**

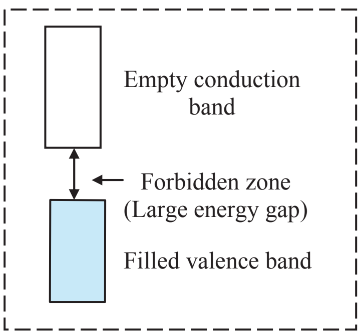
Metallic conductors

e.g. Cu, Al
- Conductivity: **10^4 to 10^7** $Ohm^{-1}\ m^{-1}$
- Band gap = No



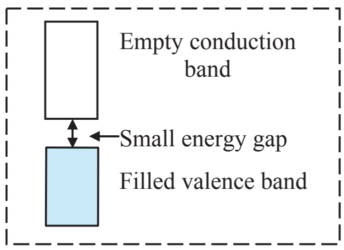
Insulators

e.g. Diamond
- Conductivity: **10^{-20} to 10^{-10}** $Ohm^{-1}\ m^{-1}$
- Band gap = Large



Semiconductors

e.g. Si, Ge
- Conductivity: **10^{-6} to 10^4** $Ohm^{-1}\ m^{-1}$
- Band gap = small



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

Substance	Characteristics	Examples
Diamagnetic materials	• Repelled weakly in magnetic field. • All electrons are paired.	N_2, F_2, NaCl, H_2O, benzene, etc.
Paramagnetic materials	• Weakly attracted in magnetic field. • Unpaired electrons are present. • Permanent magnetisation is not possible.	Oxygen, Cu^{2+}, Fe^{3+}, Cr^{3+}, etc.
Ferromagnetic materials	• Strongly attracted in magnetic field. • Unpaired electrons are present. • Permanent magnetisation is possible.	Fe, Co, Ni, Gd, CrO_2, etc.

Important Formulae

1. **Density (ρ)** = $\frac{M\,n}{a^3\,N_A}$

Where M is molar mass of the substance,
n is no. of particles per unit cell,
a is edge length of the unit cell,
N_A is Avogadro number.

2. **Packing efficiency**

$= \frac{\text{Volume occupied by particles in unit cell}}{\text{Total volume of unit cell}} \times 100$

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

sc: $r = \frac{a}{2} = 0.5000\ a$

bcc: $r = \frac{\sqrt{3}}{4}a = 0.4330\ a$

fcc: $r = \frac{\sqrt{2}}{4}a = 0.3535\ a$

4. **Volume of one particle:**

sc: $0.5237\ a^3$
bcc: $0.34\ a^3$
fcc: $0.185\ a^3$

5. **Total volume occupied by particles in unit cell:**

sc: $0.5237\ a^3$
bcc: $0.68\ a^3$
fcc: $0.74\ a^3$

6. **Number of atoms in *x* g of metal** = $\frac{x\,n}{\rho\,a^3}$

7. **Number of unit cells in *x* g of metal** = $\frac{x}{\rho\,a^3}$

8. **Number of unit cells in volume (V) of metal**

$= \frac{V}{a^3}$

EXERCISE

Theory Questions for Practice

1.2 Types of solids

1. Give the properties of crystalline solids. **[2 Marks]**

Ans: *Refer Q.6.*

2. Write four properties of amorphous solids. **[2 Marks]**

Ans: *Refer Q.8.*

3. Define isomorphous and polymorphous substances. **[2 Marks]**

Ans: *Refer Q.13.*

1.3 Classification of crystalline solids

4. Write any two properties of ionic solids. **[1 Mark]**

Ans: *Refer Q.16.*

5. State any two properties of molecular solids. **[1 Mark]**

Ans: *Refer Q.22.*

6. What are metallic crystals? Give two examples. **[2 Marks]**

Ans: *Refer Q.26.(i).*

1.4 Crystal structure

7. Define the term 'lattice'. **[1 Mark]**

Ans: *Refer Q.32.*

8. Define unit cell. **[1 Mark]**

Ans: *Refer Q.35.*

9. What are the four different types of unit cells? **[2 Marks]**

Ans: *Refer Q.37.*

1.5 Cubic system

10. Find the number of atoms in bcc unit cell. **[2 Marks]**

Ans: *Refer Q.43.*

11. Write the number of particles present in fcc per unit cell. [1 Mark] [July 23]

Ans: 4 particles per unit cell

12. A face centred cube (fcc) consists of how many atoms? Explain. [2 Marks] [July 16]

OR

Calculate the number of atoms in a unit cell of a metal crystallising in face centred cubic structure. [2 Marks] [July 17]

Ans: *Refer Q.44.*

13. Derive the relationship between molar mass, density of a substance and the edge length of unit cell. [2 Marks]

Ans: *Refer Q.46.*

1.6 Packing of particles in crystal lattice

14. Define: Coordination number. [1 Mark]

Ans: *Refer Q.52.(i)*

15. Draw a diagram showing square close packing in two-dimensions. [1 Mark]

Ans: *Refer Q.55.(i)-Diagram.*

16. With labelled diagram, explain the two dimensional hexagonal close packing in solids. [2 Marks]

Ans: *Refer Q.55.(ii)*

17. Draw diagram of octahedral void. [1 Mark]

Ans: *Refer Q.63.*

18. What is the ratio of octahedral holes to the number of anions in hexagonal closed packed structure? [1 Mark] [Mar 19]

Ans: Ratio is 1:1.

1.7 Packing efficiency

19. Define: Packing efficiency. [1 Mark]

Ans: *Refer Q.66.(ii)*

20. Calculate the percentage efficiency of packing in case of simple cubic cell. [2 Marks][Mar 17]

Ans: *Refer Q.67.*

21. Give the relation between radius of atom and edge length in body centered cubic crystal. [1 Mark] [July 19]

Ans: $r = \frac{\sqrt{3}}{4} a$

22. Calculate the packing efficiency of fcc unit cell. [3 Marks]

Ans: *Refer Q.69.*

23. Write the formula to calculate the number of unit cells in *x* g of metallic crystal. [1 Mark]

Ans: *Refer Q.73.(ii)*

1.8 Crystal defects or imperfections

24. Define: Point defects. [1 Mark]

Ans: *Refer Q.91.(i)*

25. Name the different types of point defect. [1 Mark]

Ans: *Refer Q.91.(ii)*

26. What is Schottky defect? [1 Mark] [July 19]

Ans: *Refer Q.96.(ii, iv)*

27. Give the conditions for the formation of Schottky defect. [2 Marks]

Ans: *Refer Q.97.*

28. What are Schottky defect and Frenkel defect? [2 Marks] [Oct 13]

Ans: *Refer Q.96.(ii, iv) and Q.99.(i-a, c)*

29. Draw neat labelled diagram of the following: [2 Marks Each]

i. Schottky defect ii. Frenkel defect

Ans:

i. *Refer Q.96.* ii. *Refer Q. 99.*

30. What are the consequences of Frenkel defect? [1 Mark]

Ans: *Refer Q.99.(iii)*

31. What is substitutional impurity defect? Give an example. [2 Marks]

Ans: *Refer Q.102.*

32. Explain impurity defect in stainless steel with diagram. [2 Marks] [Mar 15]

Ans: *Refer Q.103.*

33. Explain in detail metal excess defect. [4 Marks]

Ans: *Refer Q.105.*

1.9 Electrical properties of solids

34. Define conduction band. [1 Mark]

Ans: *Refer Q.112.(i)*

35. Define band gap. [1 Mark]

Ans: *Refer Q.113.(i)*

36. What is an intrinsic semiconductor? [1 Mark]

Ans: *Refer Q.117.(vi)*

37. The electrical conductivity of a semiconductor increases with increasing temperature. Give reason. [2 Marks]

Ans: *Refer Q.118.*

38. What is n-type semiconductor? [1 Mark]

Ans: *Refer Q.127.(i)*

39. With diagram, explain p-type semiconductors? **[3 Marks]**

Ans: *Refer Q.128.*

1.10 Magnetic properties of solids

40. Define diamagnetic substances? **[1 Mark]**

Ans: *Refer Q.131.*

41. Define paramagnetic substances. **[1 Mark]**

Ans: *Refer Q.133.*

42. Give two examples of ferromagnetic substances. **[1 Mark]**

Ans: *Refer Q.136.(i)*

43. Explain with one example each, the diamagnetic, paramagnetic and ferromagnetic substances. **[3 Marks]**

Ans: *Refer Q.132, 134 and 136.*

Numericals for Practice

1.5 Cubic system

1. Copper crystallizes into fcc structure and the unit cell has length of edge 3.61×10^{-8} cm. Calculate the density of copper in g cm^{-3} if the molar mass of Cu is 63.5 g mol^{-1}. **[2 Marks]**

Ans: 8.928 g cm^{-3}

2. Silver crystallizes in fcc structure. The edge length of the unit cell is found to be 408.7 pm. Calculate density of the unit cell.
[Given: Molar mass of silver is 108 g mol^{-1}] **[2 Marks] [Oct 15]**

Ans: 10.5 g cm^{-3}

3. A metal X crystallizes in bcc structure and edge length of the unit cell is 330.6 pm. Calculate density of the metal if the molar mass of X is 93 g mol^{-1}. **[3 Marks]**

Ans: 8.55 g cm^{-3}

4. An element with molar mass 197 g/mol forms cubic unit cell with edge length of 408 pm. If density of the element is 19.3 g/cm^3, what is the nature of cubic unit cell? **[3 Marks]**

Ans: fcc or ccp

5. The density of chromium metal is 7.29 g cm^{-3}. If the unit cell is cubic with edge length of 289 pm, determine the type of unit cell. (Molar mass of Cr = 52 g mol^{-1}). **[3 Marks]**

Ans: bcc

1.7 Packing efficiency

6. Atoms of element B form hcp lattice and those of the element A occupy 2/3rd of tetrahedral voids. What is the formula of the compound formed by the elements A and B? **[2 Marks]**

Ans: A_4B_3

7. Atoms of element Q form ccp structure and atoms of element P occupy $1/4^{th}$ of octahedral voids. What is the formula of the compound? **[2 Marks]**

Ans: PQ_4

8. Find number of octahedral voids formed in 0.5 mol of a metal forming hcp structure? **[1 Mark]**

Ans: 3.011×10^{23}

9. A metal forms hexagonal close-packed structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids? **[2 Marks]**

Ans: 9.033×10^{23} , 6.022×10^{23}

10. Gold (atomic radius = 0.144 nm) crystallizes in a face-centred unit cell. What is the edge length of the unit cell? **[2 Marks]**

Ans: 0.407 nm

11. An element crystallises in fcc type unit cell. Calculate the edge length of the unit cell. Given that atomic radius is 127.6 pm. **[2 Marks]**

Ans: 361 pm

12. Aluminium crystallizes in a cubic close-packed structure. Its metallic radius is 125 pm. What is the length of the side of the unit cell? **[2 Marks]**

Ans: 353.6 pm

13. A metal crystallises in fcc type unit cell. Calculate the radius of the metal atom if the edge length of the unit cell is 408 pm. **[2 Marks]**

Ans: 144.2 pm

14. The unit cell of metal X is bcc and its density is 0.97 g/cm^3. What is the radius of an atom of X if the molar mass of X is 23 g/mol? **[3 Marks]**

Ans: 1.86×10^{-8} cm = 186 pm

15. Tungsten has body-centred cubic lattice. Each edge of the unit cell is 316 pm and density of the metal is 19.35 g cm^{-3}. How many atoms are present in 50 g of the element? **[2 Marks]**

Ans: 1.64×10^{23} atoms

16. Gold has face-centred cubic lattice. The unit cell edge length is 408 pm and density of the metal is 19.27 g cm^{-3}. Calculate the number of gold atoms present in 100 g of the metal? **[2 Marks]**

Ans: 3.06×10^{23} atoms

17. Find the number of atoms present in 2 gram of crystal which has face-centred cubic (fcc) crystal lattice having edge length of 100 pm and density 10 g cm^{-3}. **[2 Marks]**

Ans: 8×10^{23} atoms

18. Calculate the number of unit cells in 0.3 g of a metal having density of 8.5 g cm^{-3} and unit cell edge length 3.25×10^{-8} cm. **[2 Marks]**

Ans: 1.03×10^{21}

19. Silver crystallizes in fcc structure with unit cell edge length of 408 pm. How many unit cells are there in 1.00 cm^3 of silver? **[2 Marks]**

Ans: 1.47×10^{22}

Scan the given Q. R. Code in *Quill - The Padhai App* to view the solutions of the Numericals.

MULTIPLE CHOICE QUESTIONS

[1 Mark Each]

1. The major binding force in diamond is ________. **[Oct 14]**
   (A) covalent bond
   (B) ionic bond
   (C) metallic bond
   (D) coordinate covalent bond

*2. Molecular solids are ________.
   (A) crystalline solids (B) amorphous solids
   (C) ionic solids (D) metallic solids

3. Quartz is a/an ________ solid.
   (A) ionic (B) molecular
   (C) covalent network (D) amorphous

4. In a solid metal, the attractive interactions between cations and mobile electrons constitute the ________.
   (A) covalent bonds
   (B) weak dipole-dipole interactions
   (C) ionic bonds
   (D) metallic bonds

5. Number of types of orthorhombic unit cell is ________. **[July 18]**
   (A) 7 (B) 3 (C) 4 (D) 2

6. The number of atoms per unit cell of body centred cube is: **[Feb 20]**
   (A) 1 (B) 2 (C) 4 (D) 6

Scan the adjacent QR Code to know more about our ***"Board Questions with Solutions"*** book for Std. XII (Sci.) and Learn about the types of questions that are asked in the XII Board Examination.

7. Na and Mg crystallize in bcc and fcc type crystals respectively, then the number of atoms of Na and Mg present in the unit cell of their respective crystal is ________.
   (A) 4 and 2 (B) 9 and 14
   (C) 14 and 9 (D) 2 and 4

*8. Which of the following is CORRECT?
   (A) Four spheres are involved in the formation of tetrahedral void.
   (B) The centres of spheres in octahedral voids are at the apices of a regular tetrahedron.
   (C) If the number of atoms is N, the number of octahedral voids is 2N.
   (D) If the number of atoms is N/2, the number of tetrahedral voids is 2N.

*[**Note:** The above question is modified so as to select appropriate option as per textual concept]*

*9. In crystal lattice formed by bcc unit cell, the void volume is ________.
   (A) 68 % (B) 74 %
   (C) 32 % (D) 26 %

10. The relation between radius of sphere and edge length in body centered cubic lattice is given by formula: **[Mar 23]**
   (A) $\sqrt{3}r = 4a$ (B) $r = \frac{\sqrt{3}}{a} \times 4$
   (C) $r = \frac{\sqrt{3}}{4}a$ (D) $r = \frac{\sqrt{2}}{4} \times a$

*11. The coordination number of atoms in bcc crystal lattice is ________.
   (A) 2 (B) 4
   (C) 6 (D) 8

12. The CORRECT relation between edge length and radius of an atom in simple cubic lattice is ________. **[July 22]**
   (A) $2a = r$ (B) $\sqrt{3}a = 4r$
   (C) $a = 2r$ (D) $\sqrt{2}a = 4r$

*13. Pb has fcc structure with edge length of unit cell 495 pm. Radius of Pb atom is ________.
   (A) 205 pm (B) 185 pm
   (C) 260 pm (D) 175 pm

14. A metal crystallizes with a face-centred cubic lattice. The edge length of the unit cell is 408 pm. The diameter of the metal atoms is ________.
   (A) 288 pm (B) 408 pm
   (C) 144 pm (D) 204 pm

*15. A compound forms hcp structure. Number of octahedral and tetrahedral voids in 0.5 mole of substance is respectively _______.
(A) 3.011×10^{23}, 6.022×10^{23}
(B) 6.022×10^{23}, 3.011×10^{23}
(C) 4.011×10^{23}, 2.011×10^{23}
(D) 6.011×10^{23}, 12.022×10^{23}

16. An ionic compound crystallises in fcc type structure with 'A' ions at the centre of each face and 'B' ions occupying corners of the cube. The formula of compound is _______. **[Mar 17]**
(A) AB_4 (B) A_3B
(C) AB (D) AB_3

17. Schottky defects are observed in which solid among the following?
(A) Silver iodide
(B) Brass
(C) Zinc sulphide
(D) Silver bromide

*18. In Frenkel defect, _______.
(A) electrical neutrality of the substance is changed
(B) density of the substance is changed
(C) both cation and anion are missing
(D) overall electrical neutrality is preserved

19. When NaCl crystal is heated in the atmosphere of sodium vapour, NaCl shows _______ colour due to the formation of F-centre.
(A) blue (B) green
(C) yellow (D) red

20. ________ is an example of conductor with overlapping bands.
(A) Metallic magnesium
(B) Metallic sodium
(C) Pure germanium
(D) Diamond

21. In insulators, the valence band is _______ and the conduction band is _______.
(A) empty ; completely filled with electrons
(B) empty ; also empty
(C) partially filled with electrons ; completely filled with electrons
(D) completely filled with electrons ; empty

22. Pure silicon is an example of _______.
(A) intrinsic semiconductor
(B) n-type semiconductor
(C) extrinsic semiconductor
(D) insulator

23. Electrical conductivity of metals _______ and that of semiconductor ________ with increasing temperature.
(A) decreases ; decreases
(B) decreases ; increases
(C) increases; increases
(D) increases; decreases

*24. Which of the following is n-type semiconductor?
(A) Pure Si
(B) Si doped with As
(C) Si doped with Ga
(D) Ge doped with In

25. To prepare an n-type semiconductor, the impurity to be added to silicon should have the following number of valence electrons. **[Mar 14]**
(A) 2 (B) 3 (C) 4 (D) 5

26. p-type semi-conductors are made by mixing silicon with impurities of _______. **[Mar 15]**
(A) germanium (B) boron
(C) arsenic (D) antimony

27. Which of the following is an example of diamagnetic substance?
(A) CrO_2 (B) O_2 (C) Ni (D) NaCl

28. Which of the following is a ferromagnetic substance?
(A) O_2 (B) H_2O (C) Fe (D) N_2

29. Benzene and oxygen are examples of _______.
(A) diamagnetic and paramagnetic substances respectively
(B) diamagnetic and ferromagnetic substances respectively
(C) diamagnetic substances
(D) paramagnetic substances

30. Which of the following will retain magnetism even after the removal of external magnetic field?
(A) F_2 (B) Co (C) H_2O (D) O_2

ANSWERS TO MULTIPLE CHOICE QUESTIONS

1.	(A)	2.	(A)	3.	(C)	4.	(D)
5.	(C)	6.	(B)	7.	(D)	8.	(A)
9.	(C)	10.	(C)	11.	(D)	12.	(C)
13.	(D)	14.	(A)	15.	(A)	16.	(B)
17.	(D)	18.	(D)	19.	(C)	20.	(A)
21.	(D)	22.	(A)	23.	(B)	24.	(B)
25.	(D)	26.	(B)	27.	(D)	28.	(C)
29.	(A)	30.	(B)				

COMPETITIVE CORNER

1. Element 'B' forms ccp structure and 'A' occupies half of the octahedral voids, while oxygen atoms occupy all the tetrahedral voids. The structure of bimetallic oxide is _______. **[JEE (Main) 2019]**

(A) AB_2O_4 (B) A_4B_2O
(C) A_2B_2O (D) A_2BO_4

Hint: In cubic close packing (i.e., in ccp structure) there are 4 octahedral voids and 8 tetrahedral voids in a unit cell.
The number of 'B' atoms in ccp unit cell = 4
Since, 'A' occupies half of the octahedral voids, the no. of atoms of 'A' in ccp unit cell = 2.
Also, oxygen atoms occupy all the tetrahedral voids = 8
∴ The ratio of number of atoms of A, B and oxygen (O) = 2 : 4 : 8 = 1 : 2 : 4
Hence, the structure of bimetallic oxide is AB_2O_4.

2. Formula of nickel oxide with metal deficiency defect in its crystal is $Ni_{0.98}O$. The crystal contains Ni^{2+} and Ni^{3+} ions. The fraction of nickel existing as Ni^{2+} ions in the crystal is _______. **[NEET (Odisha) 2019]**

(A) 0.31 (B) 0.96 (C) 0.04 (D) 0.50

Hint: Let Ni^{3+} be x. Hence, Ni^{2+} will be $0.98 - x$.
∴ $3x + 2(0.98 - x) - 2 = 0$
∴ $x = 0.04$
∴ Fraction of nickel existing as $Ni^{3+} = \frac{0.04}{0.98} = 0.04$
∴ Fraction of nickel existing as $Ni^{2+} = 0.96$

3. Which one of the following compounds shows both, Frenkel as well as Schottky defects? **[NEET (UG) P-II 2020]**

(A) ZnS (B) AgBr
(C) AgI (D) NaCl

4. Lithium crystallises into body centered cubic structure. What is the radius of lithium if edge length of it's unit cell is 351 pm? **[MHT CET 2020]**

(A) 75.50 pm (B) 151.98 pm
(C) 240.80 pm (D) 300.50 pm

Hint: Lithium crystallizes in bcc structure.

For bcc cell, $r = \frac{\sqrt{3}}{4}a = 0.4330\ a$

$= 0.4330 \times 351\ pm = 151.983\ pm$

5. The edge length of fcc type unit cell of copper having atomic radius 127.6 pm is equal to _______. **[MHT CET 2020]**

(A) 361 pm (B) 295 pm
(C) 331 pm (D) 378 pm

Hint: For fcc type of unit cell,

$r = \frac{\sqrt{2}}{4}a = 0.3535\ a$

∴ $a = \frac{127.6}{0.3535} = 360.96 \approx 361\ pm$

6. What is the number of atoms present per unit cell of aluminium having edge length 4 Å? (If density of Al = 2.7 g cm^{-3}, At. Mass of Al = 27) **[MHT CET 2020]**

(A) 2 (B) 1 (C) 4 (D) 8

Hint: For a given unit cell of aluminium,
$a = 4\ Å = 4 \times 10^{-8}$ cm,
Density of Al = 2.7 g cm^{-3},
Mass of the element Al = 27 g/mol

Density $(\rho) = \frac{M\,n}{a^3\,N_A}$

$n = \frac{2.7\,g\,cm^{-3} \times (4\times10^{-8})^3\,cm^3 \times 6.022\times10^{23}\ atom\ mol^{-1}}{27\,g\,mol^{-1}}$

$= 3.85 \approx 4$ atoms

7. The CORRECT option for the number of body-centred unit cells in all 14 types of Bravais lattice unit cells is_______. **[NEET (UG) 2021]**

(A) 5 (B) 2 (C) 3 (D) 7

Hint: Cubic, tetragonal and orthorhombic crystal systems have body-centred unit cells.

8. What is the value of density of an element having bcc structure with edge length 5 Å? (Atomic mass = 70 g mol^{-1}) **[MHT CET 2021]**

(A) 4.35 g cm^{-3} (B) 3.72 g cm^{-3}
(C) 5.35 g cm^{-3} (D) 1.86 g cm^{-3}

Hint: For a bcc lattice, number of atoms per unit cell is n = 2.

Density, $\rho = \frac{M\,n}{a^3\,N_A}$

$\rho = \frac{70\ g\ mol^{-1} \times 2\ atom}{(5 \times 10^{-8})^3\ cm^3 \times 6.022 \times 10^{23}\ atom\ mol^{-1}}$

$= 1.86\ g\ cm^{-3}$

9. Calculate the number of atoms in 20 grams metal which crystallises to simple cubic structure having unit cell edge length 340 pm. (density of metal = 9.8 g cm^{-3}) **[MHT CET 2022]**

(A) 4.95×10^{22} (B) 5.81×10^{22}
(C) 5.19×10^{22} (D) 5.42×10^{22}

Hint: Edge length (a) = 340 pm = 3.4×10^{-8} cm
For simple cubic structure unit cell, n = 1

Number of atoms in x g of element $= \frac{x\,n}{\rho\,a^3}$

$= \frac{20\ g \times 1}{9.8\ g\ cm^{-3} \times (3.4 \times 10^{-8}\ cm)^3}$

$= 5.19 \times 10^{22}$

10. Calculate the molar mass of an element having density 2.8 g cm^{-3} and forms fcc unit cell.
$[a^3.N_A = 38.5\ cm^3\ mol^{-1}]$ **[MHT CET 2023]**
(A) 26.95 g mol^{-1} (B) 23.5 g mol^{-1}
(C) 29.2 g mol^{-1} (D) 21.6 g mol^{-1}

Hint: For fcc unit cell, n = 4.

$$\text{Density } (\rho) = \frac{M\,n}{a^3\,N_A}$$

$$2.8 = \frac{M \times 4}{38.5}$$

$$M = \frac{2.8 \times 38.5}{4} = 26.95\ g\ mol^{-1}$$

11. What is the number of octahedral and tetrahedral voids in 0.5 mole compound respectively if it forms hcp structure? **[MHT CET 2023]**
(A) 3.011 × 1023 and 6.022 × 1023
(B) 6.022 × 1023 and 3.011 × 1023
(C) 2.011 × 1023 and 4.022 × 1023
(D) 6.022 × 1023 and 1.204 × 1024

Hint:
Number of atoms in 0.5 mol
= 0.5 × NA= 0.5 × 6.022 × 1023 = 3.011 × 1023
Number of octahedral voids
= Number of atoms = 3.011 × 1023
Number of tetrahedral voids
= 2 × Number of atoms
= 2 × 3.011 × 1023 = 6.022 × 1023

12. A compound is formed by two elements A and B. The element B forms cubic close packed structure and atoms of A occupy 1/3 of tetrahedral voids. If the formula of the compound is A_xB_y, then the value of x + y is in option **[NEET (UG) 2023]**
(A) 4 (B) 3
(C) 2 **(D) 5**

Hint: In ccp structure, the number tetrahedral voids are twice than the number of atoms.
The number of atoms of 'B' is n.
Number of 'A' atoms occupying tetrahedral voids = $\frac{1}{3} \times 2n$

Ratio of A : B = $\frac{1}{3} \times 2n : n = 2 : 3$

Hence, x = 2, y = 3 ande x + y = 5

13. How many number of tetrahedral voids are formed in 5 mol of a compound having cubic close packed structure? (Choose the CORRECT option) **[NEET (UG) Manipur 2023]**
(A) 3.011×10^{24}
(B) 6.022×10^{24}
(C) 1.550×10^{24}
(D) 3.011×10^{25}

Hint: In a ccp unit cell having 'N' number of atoms, there are '2N' number of tetrahedral voids.
Number of tetrahedral voids formed in a 5 mol of a compound having ccp structure
$= 5 \times 2 \times 6.022 \times 10^{23} = 6.022 \times 10^{24}$ voids

Time: 1 Hour 30 Min	TOPIC TEST	Total Marks: 25

SECTION A

Q.1. Select and write the correct answer: **[04]**

i. Solid SO_2 is a/an _______ solid.
(A) ionic (B) molecular
(C) covalent network (D) amorphous

ii. Identify the paramagnetic substance.
(A) Oxygen (B) Benzene
(C) Water (D) Nickel

iii. What is the packing efficiency of bcc unit cell?
(A) 26% (B) 74%
(C) 52.4% (D) 68%

iv. Which of the following crystallizes in simple cubic closed packed structure?
(A) Copper (B) Zinc
(C) Silver (D) Polonium

Q.2. Answer the following: **[03]**

i. A compound forms fcc structure. What is the number of octahedral voids formed in 0.3 mol of it?
ii. Name the type of semiconductor obtained by doping Ge with In.

iii. Define: Unit cell.

SECTION B

Attempt any Four: **[08]**

Q.3. Calculate the number of atoms in bcc unit cell.

Q.4. What is a Schottky defect?

Q.5. Classify the following solids into different types:
i. Sodium phosphate ii. Diamond iii. NH_3 molecule iv. Calcium

Q.6. Describe the four different types of unit cells.

Q.7. An element crystallizes in bcc unit cell with edge length of 290 pm. What is the radius of an atom of the element?

Q.8. Give the characteristics of covalent network crystals.

SECTION C

Attempt any Two: **[06]**

Q.9. Calculate percentage efficiency of packing in face-centred cubic unit cell.

Q.10. Niobium crystallizes bcc structure. If the density of niobium is 8.55 g/cm^3 and length of unit cell edge is 330.6 pm, then find out:
i. Number of atoms in 0.2 g of niobium and
ii. Number of unit cells present in 0.2 g of niobium?

Q.11. i. Obtain the relationship between density of a substance and the edge length of unit cell.
ii. Define point defect.

SECTION D

Attempt any One: **[04]**

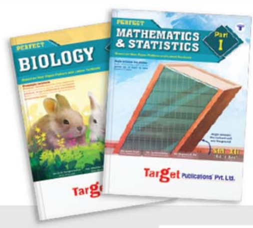
Q.12. i. Distinguish between ionic solids and molecular solids.
ii. An ionic compound is formed by two elements A and B. The atoms of element B form fcc structure and the atoms of A occupy 1/3rd of tetrahedral voids. What is the formula of the ionic compound?

Q.13. i. When gold crystallizes, it forms face-centred cubic cells. The unit cell edge length is 408 pm. Calculate the density of gold. Molar mass of gold is 197 g/mol.
ii. Write the names of the seven crystal systems.

Scan the given Q. R. Code in *Quill - The Padhai App* to view the solutions of the Topic Test.


Practice Test
End Test
00:00:05
Which of the following temperature will read the same value on Celsius and Fahrenheit scales?
(A)- 40°
(B)+ 40°
(C)- 80°
(D)- 20°
Get the next one right too!
Previous
Next


Quill
The Padhai App


BIOLOGY
MATHEMATICS & STATISTICS