CHEMISTRY

BOOKS - U-LIKE CHEMISTRY (HINGLISH)

SOLID STATE

Ncert Intext Questions

1. Why are solids rigid ?

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2. Why do solids have a definite volume ?

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3. Classify the following as amorphous or crystalline solids :

Polyurethane, naphthalene, benzoic acid, teflon, potassium nitrate, cellophane, polyvinyl chloride, fibre glass and copper.

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4. Why is glass considered a supercooled liquid ?

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5. Refractive index of a solid is observed to have the same value along all directions. Comment on the nature of this solid. Would it show cleavage property ?

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6. Classify the following solids in different categories based on the nature of intermolecular forces operating in them :

Potassium sulphate, tin, benzene, urea, ammonia, water, zinc sulphide, graphite, rubidium, argon, silicon carbide. Solid Category Potassium sulphate Ionic

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7. Solid A is a very hard electrical insulator in solid as well as in molten state and melts at extremely high temperature. What type of solid is it ?

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8. Ionic solids conduct electricity in molten state but not in solid state. Explain.

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9. What type of solids are electrical conductors, malleable and ductile ?

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10. Give the significance of a 'lattice point.

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11. Name the parameters that characterise a unit cell.

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12. Distinguish between

(i) Hexagonal and monoclinic unit cells.

(ii) Face-centred and end-centred unit cells.

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13. Explain how much portion of an atom located at (i) corner and (i) body-centre of a cubic unit cell is part of its neighbouring unit cell.

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14. What is the two dimensional coordination number of a molecule in square close-packed layer ?

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15. A compound 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 ?

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16. A compound is formed by two elements M and N. The element N forms ccp and atoms of M occupy $1/3rd$ of tetrahedral voids. What is the

formula of the compound ?

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17. Which of the following lattices has the highest packing efficiency (i) simple cubic (ii) body-centred cubic and (iii) hexagonal close-packed lattice ?

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18. An element with molar mass $2.7 \times 10^{-2} kgmol^{-1}$ forms a cubic unit cell with edge length 405 pm. If its density is $2.7 \times 10^{3} kgm^{-3}$, what is the nature of the cubic unit cell ?

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19. What type of defect can arise when a solid is heated ? Which physical property is affected by it and in what way ?

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20. What type of stoichiometric defect is shown by :

(i) Zns(ii) AgBr

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21. Explain how vacancies are introduced in an ionic solid when a cation of higher valence is added as an impurity in it.

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22. Ionic solids, which have anionic vacancies due to metal excess defect, develop colour. Explain with the help of a suitable example.

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23. A group 14 element is to be converted into n-type semiconductor by doping it with a suitable impurity. To which group should this impurity belong ?

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24. What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic ? Justify your answer.

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Ncert Textbook Exercises

1. Define the term 'amorphous'. Give a few examples of amorphous solids.

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2. What makes a glass different from a solid such as quartz ? Under what conditions could quartz be converted into glass ?

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3. Classify each of the following solids as ionic, metallic, molecular, network (covalent) or amor- phous :

(i) Tetra phosphorus decoxide (P_4O_{10}) (ii) Ammonium phosphate $(NH$

(iii) Sic $(iv) I_2$

(v) P_4 (vi) Plastics

(vii) Graphite (viii) Brass

(ix) Rb (x) LiBr

(xi) Si

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4. (i) What is meant by the term 'coordination number ?

(ii) What is the coordination number of atoms :

(a) in a cubic close-packed structure ?

(b) in a body-centred cubic structure ?

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5. How can you determine the atomic mass of an unknown metal if you know its density and the dimension of its unit cell ? Explain.

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6. "Stability of a crystal is reflected in the magnitude of its melting points.' Comment. Collect melting points of solid water, ethyl alcohol, diethyl ether and methane from a data book. What can you say about the intermolecular forces between these molecules ?

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7. How will you distinguish between the following pairs of terms :

(i) Hexagonal close-packing and cubic close-packing ?

(ii) Crystal lattice and unit cell ?

(iii) Tetrahedral void and octahedral void ?

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8. How many lattice points are there in one unit cell of each of the following lattice ?

(i) Face-centred cubic

(ii) Face-centred tetragonal

(iii) Body-centred cubic.

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9. Explain

(i) The basis of similarities and differences between metallic and ionic crystals.

(ii) Ionic solids are hard and brittle.

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10. Calculate the efficiency of packing in case of a metal crystal for

(i) simple cubic

(ii) body-centred cubic

(iii) face-centred cubic (with the assumptions that atoms are touching each other).

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11. Silver crystallises in fcc lattice. If edge length of the cell is 4.07×10^{-8} cm and density is $10.5 g cm^{-3}$, calculate the atomic mass of silver.

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12. A cubic solid is made of two elements P and Q. Atoms of Q are at the corners of the cube and P at the body-centre. What is the formula of the compound ? What are the coordination numbers of P and Q ?

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13. Niobium crystallises in body-centred cubic structure. If density is $8.55 gcm^3$, calculate atomic radius of niobium using its atomic mass of 93 u.

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14. If the radius of the octahedral void is r and radius of the atoms in close-packing is R, derive relation between r and R.

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15. Copper crystallises into a fcc lattice with edge length 3.61×10^{-8} cm. Show that the calculated density is in agreement with its measured value of $8.92 gcm^{-8}$.

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16. Analysis shows that nickel oxide has the formula $Nio_{0.98}O_{1.00}$. What fractions of nickel exist as Ni^{2+} and Ni^{3+} ions ?

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17. What is a semiconductor ? Describe the two main types of semiconductors and contrast their conduction mechanism.

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18. Non-stoichiometric cuprous oxide, Cu_2O can be prepared in laboratory. In this oxide, copper to oxygen ratio is slightly less than $2:1$. Can you account for the fact that this substance is a p-type semiconductor ?

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19. Ferric oxide crystallises in a hexagonal close-packed array of oxide ions with two out of every three octahedral holes occupied by ferric ions. Derive the formula of the ferric oxide.

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20. Classify each of the following as being either a p-type or a n-type semiconductor :

(i) Ge doped with In

(ii) B doped with Si.

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21. Gold [atomic radius = 0.144 nm] crystallises in face-centred unit cell. What is the length of a side of the cell ?

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22. In terms of band theory, what is the difference

(i) between a conductor and an insulator,

(ii) between a conductor and a semiconductor ?

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23. Explain the following terms with suitable examples :

(i) Schottky defect

(ii) Frenkel defect

(iii) Interstitials

(iv) F-centres.

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24. Aluminium crystallises in a cubic close-packed structure. Its metallic radius is 125 pm.

(i) What is the length of the side of the unit cell ?

(ii) How many unit cells are there in $1.00cm^3$ of aluminium ?

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25. If NaCl is doped with $10^{-3} mol\ \%\ of SrCl_2$, what is the concentration of cation vacancies ?

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26. Explain the following with suitable examples :

(i) Ferromagnetism

(ii) Paramagnetism

(iii) Ferrimagnetism

(iv) Antiferromagnetism

(v) 12-16 and 13-15 group compounds.

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Case Based Source Based Integrated Questions

1. Crystalline solids have a sharp melting point. At a characteristic temperature they melt abruptly and become liquid. On the other hand, amorphous solids soften, melt and start flowing over a range of temperature and can be moulded and blown into various shapes. Amorphous solids have the same structural features as liquids and are conveniently regarded as extremely viscous liquids. They may become crystalline at some temperature. Some glass objects from ancient civilisations are found to become milky in appearance because of some crystallisation. Like liquids, amorphous solids have a tendency to flow, though very slowly. Therefore, sometimes these are called pseudo solids or super cooled liquids.

1. Give a characteristic of crystalline solids.

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temperature and can be moulded and blown into various shapes. Amorphous solids have the same structural features as liquids and are conveniently regarded as extremely viscous liquids. They may become crystalline at some temperature. Some glass objects from ancient civilisations are found to become milky in appearance because of some crystallisation. Like liquids, amorphous solids have a tendency to flow, though very slowly. Therefore, sometimes these are called pseudo solids or super cooled liquids.

2. What happens when an amorphous solids is heated ?

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3. What is the similarity between amorphous solids and liquids ?

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4. Crystalline solids have a sharp melting point. At a characteristic temperature they melt abruptly and become liquid. On the other hand, amorphous solids soften, melt and start flowing over a range of temperature and can be moulded and blown into various shapes. Amorphous solids have the same structural features as liquids and are conveniently regarded as extremely viscous liquids. They may become crystalline at some temperature. Some glass objects from ancient civilisations are found to become milky in appearance because of some crystallisation. Like liquids, amorphous solids have a tendency to flow, though very slowly. Therefore, sometimes these are called pseudo solids

or super cooled liquids.

4. Why do very old glass panes become milky in appearance ?

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5. Crystalline solids have a sharp melting point. At a characteristic temperature they melt abruptly and become liquid. On the other hand, amorphous solids soften, melt and start flowing over a range of temperature and can be moulded and blown into various shapes. Amorphous solids have the same structural features as liquids and are conveniently regarded as extremely viscous liquids. They may become crystalline at some temperature. Some glass objects from ancient civilisations are found to become milky in appearance because of some crystallisation. Like liquids, amorphous solids have a tendency to flow, though very slowly. Therefore, sometimes these are called pseudo solids or super cooled liquids.

5. What are the other names given to amorphous solids ?

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6. Metals are orderly collection of positive ions surrounded by and held together by a sea of free electrons. These electrons are mobile and are evenly spread out throughout the crystal. Each metal atom contributes one or more electrons towards this sea of mobile electrons. These free and mobile electrons are responsible for high electrical and thermal conductivity of metals. When an electric field is applied, these electrons flow through the network of positive ions. Similarly, when heat is supplied to one portion of a metal, the thermal energy is uniformly spread throughout by free electrons. Another important characteristic of metals is their lustre and colour in certain cases. This is also due to the presence of free electrons in them. Metals are highly malleable and ductile.

1. Give the composition of metals.

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7. Metals are orderly collection of positive ions surrounded by and held together by a sea of free electrons. These electrons are mobile and are evenly spread out throughout the crystal. Each metal atom contributes

one or more electrons towards this sea of mobile electrons. These free and mobile electrons are responsible for high electrical and thermal conductivity of metals. When an electric field is applied, these electrons flow through the network of positive ions. Similarly, when heat is supplied to one portion of a metal, the thermal energy is uniformly spread throughout by free electrons. Another important characteristic of metals is their lustre and colour in certain cases. This is also due to the presence of free electrons in them. Metals are highly malleable and ductile.

2. Where does the sea of electrons come from ?

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8. Metals are orderly collection of positive ions surrounded by and held together by a sea of free electrons. These electrons are mobile and are evenly spread out throughout the crystal. Each metal atom contributes one or more electrons towards this sea of mobile electrons. These free and mobile electrons are responsible for high electrical and thermal conductivity of metals. When an electric field is applied, these electrons flow through the network of positive ions. Similarly, when heat is supplied

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How do you explain the electrical conductivity and thermal conductivity of metals ?

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9. Metals are orderly collection of positive ions surrounded by and held together by a sea of free electrons. These electrons are mobile and are evenly spread out throughout the crystal. Each metal atom contributes one or more electrons towards this sea of mobile electrons. These free and mobile electrons are responsible for high electrical and thermal conductivity of metals. When an electric field is applied, these electrons flow through the network of positive ions. Similarly, when heat is supplied to one portion of a metal, the thermal energy is uniformly spread throughout by free electrons. Another important characteristic of metals is their lustre and colour in certain cases. This is also due to the presence

of free electrons in them. Metals are highly malleable and ductile.

4. "Metals are highly malleable and ductile." What are the applications of these properties ?

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10. Various combinations of n-type and p-type semiconductors are used for making electronic components. Diode is a combination of n-type and p-type semiconductors and is used as a rectifier. Transistors are made by sandwiching a layer of one type of semiconductor between two layers of the other type of semiconductor. npn and pnp type of transistors are used to detect or amplify radio or audio signals. The solar cell is an efficient photo-diode used for conversion of light energy into electrical energy. Germanium and silicon are group 14 elements and therefore, have a characteristic valence of four and form four bonds as in diamond. A large variety of solid state materials have been prepared by combination of groups 13 and 15 or 12 and 16 to simulate average valence of four as in Ge or Si. Typical compounds of groups 13 - 15 are InSb, AIP and GaAs, Gallium arsenide (GaAs) semiconductors have very fast response and have

revolutionised the design of semiconductor devices. ZnS, CdS, CdSe and HgTe are examples of groups 12 - 16 compounds. In these compounds, the bonds are not perfectly covalent and the ionic character depends on the electronegativities of the two elements.

1. How are electronic components made ?

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11. Various combinations of n-type and p-type semiconductors are used for making electronic components. Diode is a combination of n-type and p-type semiconductors and is used as a rectifier. Transistors are made by sandwiching a layer of one type of semiconductor between two layers of the other type of semiconductor. npn and pnp type of transistors are used to detect or amplify radio or audio signals. The solar cell is an efficient photo-diode used for conversion of light energy into electrical energy. Germanium and silicon are group 14 elements and therefore, have a characteristic valence of four and form four bonds as in diamond. A large variety of solid state materials have been prepared by combination of groups 13 and 15 or 12 and 16 to simulate average valence of four as in

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2. What are the applications of npn and pnp types of transistors ?

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12. Various combinations of n-type and p-type semiconductors are used for making electronic components. Diode is a combination of n-type and p-type semiconductors and is used as a rectifier. Transistors are made by sandwiching a layer of one type of semiconductor between two layers of the other type of semiconductor. npn and pnp type of transistors are used to detect or amplify radio or audio signals. The solar cell is an efficient photo-diode used for conversion of light energy into electrical energy. Germanium and silicon are group 14 elements and therefore, have a characteristic valence of four and form four bonds as in diamond. A

large variety of solid state materials have been prepared by combination of groups 13 and 15 or 12 and 16 to simulate average valence of four as in Ge or Si. Typical compounds of groups 13 - 15 are InSb, AIP and GaAs, Gallium arsenide (GaAs) semiconductors have very fast response and have revolutionised the design of semiconductor devices. ZnS, CdS, CdSe and HgTe are examples of groups 12 - 16 compounds. In these compounds, the bonds are not perfectly covalent and the ionic character depends on the electronegativities of the two elements.

3. Name some compounds of groups 13-15 which have revolutionised semiconductor devices.

View Text Solution

13. Various combinations of n-type and p-type semiconductors are used for making electronic components. Diode is a combination of n-type and p-type semiconductors and is used as a rectifier. Transistors are made by sandwiching a layer of one type of semiconductor between two layers of the other type of semiconductor. npn and pnp type of transistors are used to detect or amplify radio or audio signals. The solar cell is an

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4. Give some examples of group 12-16 that are used in semiconductor devices.

View Text Solution

14. Various combinations of n-type and p-type semiconductors are used for making electronic components. Diode is a combination of n-type and p-type semiconductors and is used as a rectifier. Transistors are made by

sandwiching a layer of one type of semiconductor between two layers of the other type of semiconductor. npn and pnp type of transistors are used to detect or amplify radio or audio signals. The solar cell is an efficient photo-diode used for conversion of light energy into electrical energy. Germanium and silicon are group 14 elements and therefore, have a characteristic valence of four and form four bonds as in diamond. A large variety of solid state materials have been prepared by combination of groups 13 and 15 or 12 and 16 to simulate average valence of four as in Ge or Si. Typical compounds of groups 13 - 15 are InSb, AIP and GaAs, Gallium arsenide (GaAs) semiconductors have very fast response and have revolutionised the design of semiconductor devices. ZnS, CdS, CdSe and HgTe are examples of groups 12 - 16 compounds. In these compounds, the bonds are not perfectly covalent and the ionic character depends on the electronegativities of the two elements.

5. Comment on the nature of bonds in such compounds.

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Multiple Choice Questions

1. Solids have the following characteristics :

A. They have definite mass, volume and shape.

B. Intermolecular distances are short.

C. Intermolecular forces are strong.

D. All the above.

Answer: D

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2. Example of crystalline solids are :

A. sodium chloride and quartz.

B. sodium chloride and glass.

C. glass and plastic.

D. glass and rubber.

Answer: A

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3. Tick the wrong statement :

A. Amorphous solids are isotropic.

B. Amorphous solids are pseudo solids.

C. Amorphous solids are super cooled liquids.

D. Amorphous solids have long range order.

Answer: D

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4. Crystalline solids

A. have irregular shape.

B. definite geometrical shape.

C. gradually soften on heating.

D. do not have definite enthalpy of fusion.

Answer: B

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5. One of the best photovoltaic material fur the conversion of sunlight into electricity is

A. iron

B. zinc

C. amorphous silicon

D. aluminium

Answer: C

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6. Solid SO_2 and solid NH_3 are examples of

A. polar molecular solids.

B. hydrogen bonded molecular solids

C. non-polar molecular solids.

D. none of these.

Answer: A

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7. Silicon carbide is an example of

A. ionic solid.

B. Metallic solid

C. covalent solid.

D. Non metallic solid.

Answer: C

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8. Choose the wrong option :

Zinc sulphide

A. has low melting point.

B. is hard but brittle.

C. exists as ions.

D. has coulombic forces.

Answer: A

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9. Which of the following is not a molecular solid ?

A. H_2

B. I_2

C. CO_2

D. SiO_2

Answer: D

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10. Tetrahedral voids are surrounded by

A. 2 spheres.

B. 4 spheres.

C. 6 spheres.

D. 8 spheres.

Answer: B

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11. From the unit cell dimension, we can accurately calculate

A. Gas constant.

B. Henry's law constant.

C. Avogadro constant.

D. None of these.

Answer: C

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12. Density of a unit cell is given by

A. $d = \frac{N_A}{ZMa^3}$

B. $d = \frac{a^3 N_A}{ZM}$

C. $d = \frac{a^3 M}{ZN_A}$

D. $d = \frac{ZM}{a^3 N_A}$

Answer: D

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13. The radius r of an atom in a body-centred cubic is given by

A. $r = \frac{\sqrt{3}}{2}a$

B. $r = \frac{4}{\sqrt{3a}}$

C. $r = \frac{\sqrt{3}}{4}a$

D. $r = \frac{4a}{\sqrt{3}}$

Answer: C

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14. Total number of atoms per unit cell in a face-centred cubic unit cell is

A. 4

B. 3

C. 2

D. 1

Answer: a

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15. The packing efficiency in hcp and ccp structures is

A. $68\ \%$

B. $74\ \%$

C. $78\ \%$

D. $64\ \%$

Answer: B

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16. ZnS and AgCl show

A. Metal excess defect.

B. Schottky defect.

C. Metal deficiency defect.

D. Frenkel defect.

Answer: D

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17. Conductors have electrical conductivity in the range of

A. 10^2 to $10^7 ohm^{-1} m^{-1}$

B. 10^2 to $10^3 ohm^{-1} m^{-1}$

C. 10^8 to $10^{10} ohm^{-1} m^{-1}$

D. 10 to 100 $ohm^{-1}m^{-1}$

Answer: A

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18. The process of doping helps in

A. decreasing conductivity.

B. increasing conductivity.

C. proper mixing.

D. increasing melting point.

Answer: B

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19. Diode is a combination of the following semiconductors :

A. n-type and n-type

B. n-type and p-type

C. p-type and p-type

D. none of these

Answer: B

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20. Bohr magneton Hg has the value

A. $9.27 \times 10^{-14} Am^2$

B. $9.27 \times 10^{-18} Am^2$

C. $9.27 \times 10^{-24} Am^2$

D. $9.27 \times 10^{-21} Am^2$

Answer: C

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Assertion Reason Questions

1. Assertion (A) : Solids have definite mass, volume and shape.

Reason (R) : Solids can be classified as crystalline and amorphous.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

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2. Assertion (A) : Crystalline solids are anisotropic in nature.

Reason (R) : Crystalline solids melt at a sharp and characteristic temperature.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

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3. Assertion (A) : Glass, rubber and plastics form crystals when their liquids solidify on cooling.

Reason (R) : Solids are incompressible and rigid.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: D

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4. Assertion (A) : In H_2Cl_2 and I_2, the atoms or molecules are held by weak dispersion forces.

Reason (R) : Diamond and silicon carbide are examples of ionic solids.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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5. Assertion (A) : NaCl and MgO have coulombic forces of attraction between them.

Reason (R): Each point in a lattice is called lattice point or lattice site.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

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6. Assertion (A) : End-centred unit cells contain one constituent particle at each face besides the ones at its corners.

Reason (R) : Unit cells are of two types, primitive and centred unit cells.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: D

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7. Assertion (A) : SnO_2 and white tin possess tetragonal structure.

Reason (R) : Number of atoms per unit cell in body-centred cubic unit cell is 4.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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8. Assertion (A) : A tetrahedral void is surrounded by six spheres.

Reason (R) : In ionic solids, the bigger ions form the close packed structure and smaller ions occupy the voids.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: D

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9. Assertion (A) : Packing efficiency in simple cubic unit cell is $52.4\,\%$.

Reason (R) : Density of the unit cell is given by the relation : $d = \frac{a^3 N_A}{ZM}$.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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10. Assertion (A) : Point defects are the irregularities or deviations from ideal arrangement around a point in a crystalline substance.

Reason (R) : Schottky defect is basically a vacancy defect in ionic solids.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: B

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Fill In The Blanks

1. Ferrimagnetic substances lose ferrimagnetism on heating and become _____

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2. Pairing of electrons cancels their _____ and they lose their magnetic character.

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3. The solar cell is an efficient _____ used for the conversion of light energy into electrical energy.

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4. The conductivity of _____ semiconductor is increased by adding an appropriate amount of suitable _____.

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5. Semiconductors are solids with conductivities in the range of _____.

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Very Short Answer Questions

1. What type of stoichiometric defect is shown by AgCl ?

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2. 'Crystalline solids are anisotropic in nature.' What does this statement mean ?

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3. Write a feature which will distinguish a metallic solid from an ionic solid.

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4. What type of interactions hold the molecules together in a polar molecular solid ?

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5. Give an example of an ionic compound which shows Frenkel defect.

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6. Which point defect in crystals does not alter the density of the relevant solid ?

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7. How do metallic and ionic substances differ in conducting electricity ?

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8. A compound contains two types of atoms - X and Y. It crystallises in a cubic lattice with atom X at the corners of the unit cell and atoms Y at the body centres. What is the simplest possible formula of this compound ?

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9. What is the meaning of anisotropy ?

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10. What are amorphous solids ?

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11. What makes graphite a soft solid ?

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12. What do you mean by primitive unit cell ?

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13. What are the contributions of each face-centred atom and each corner atom ?

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14. What are the numbers of tetrahedral holes and octahedral holes if the total number of atoms in a solid is N ?

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15. Why are defects created in crystals ?

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16. Name a solid which shows both Frenkel and Schottky defects.

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17. How will you distinguish between a semiconductor and insulator ?

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18. Give two examples of intrinsic semiconductors.

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19. What is paramagnetism of a substance due to ?

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20. What type of solids are glass, rubber and plastics ?

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21. The physical properties of a material show different values when measured in different directions. What is this property known as ?

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22. What type of solids are made by three dimensional arrangement of cations and anions bound by strong coulombic forces ?

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23. What kind of solids show electrical conductivity in solid as well as molten states ?

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24. Give an example of a substance having cubic crystal system.

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25. What type of crystal structure is shown by graphite ?

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26. The number of atoms per unit cell in a solid is 4. What type of cubic unit cell is it ?

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27. Which kind of voids are surrounded by six spheres ?

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28. What is the other name for Frenkel defect ?

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29. Give an example of a solid showing Frenkel defect.

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30. Name a substance that shows both Frenkel defect as well as Schottky defect.

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31. What is the name given to the anionic sites occupied by unpaired electrons ?

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32. What is the range of electrical conductivity in insulators ?

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33. What is the unit of magnetic moment ?

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34. What type of substances are strongly attracted by magnetic field ?

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35. What type of a substances is Mno ?

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Short Answer Questions

1. Name the crystal defect that reduces the density of an ionic solid. What type of ionic substances, show this defect ?

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2. (i) What type of non-stoichiometric point defect is responsible for the pink colour of LiCI ?

(ii) What type of stoichiometric defect is shown by NaCl ?

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3. How will you distinguish between the following pairs of terms :

(i) Tetrahedral and octahedral voids.

(ii) Crystal lattice and unit cell.

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4. Account for the following :

(i) Schottky defect lowers the density of related solids.

(ii) Conductivity of Si increases on doping it with phosphorus.

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5. Silver crystallises in face-centered cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atoms just touch each other on the diagonal across the face of the unit cell. That is each face atom is touching the four corner atoms)

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6. Explain how you can determine the atomic mass of an unknown metal if you know its mass density and the dimensions of unit cell of its crystal.

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7. How do you explain the fluidity of liquids and gases and rigidity of solids ?

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8. Classify quartz and glass into the type of solids they are. What makes the two substances different from each other ?

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9. Calculate the packing efficiency of a metal crystal for a simple cubic lattice.

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10. Explain the following terms with suitable example of each :

(i) Ferromagnetism

(ii) Antiferromagnetism.

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11. In terms of band theory, explain the difference between a conductor and a semiconductor and give one example of each.

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12. Explain anisotropy in solids with the help of a diagram.

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13. Distinguish between crystalline and amorphous solids in terms of

(a) Cleavage property

(b) Heat of fusion.

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14. Sodium crystallises in a bcc unit cell. Calculate the approximate number of unit cells in 9.2 g of sodium ? $[\text{Atomic Mass of Na} = 23\ \text{u}]$

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15. What is a semiconductor ? Describe the two main types of semiconductors.

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16. The well-known mineral fluorite is chemically calcium fluoride. It is known that in one unit cell of this mineral there are $4Ca^{2+}$ ions and $8F^{-}$ ions and that Ca^{2+} ions are arranged in a fce lattice. The F^{-} ions fill all the tetrahedral holes in the face-centred cubic lattice of Ca^{2+} ions. The edge of the unit cell is 5.46×10^{-8} cm in length. The density of the solid is $3.18 gcm^{-3}$. Use this information to calculate Avogadro's number. [Molar mass of $CaF_2 = 78.08 gmol^{-1}$]

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17. What is a unit cell ? What are its parameters ? Show them by drawing a unit cell .

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18. Give one example each of hydrogen bonded molecular solid and network solid . Comment on their melting points .

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19. KF has ccp structure . Calculate the radius of unit cell if the side of the cube or edge length is 400 pm . How many F ions and octahedral voids are there in this unit cell ?

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20. Give reason :

(a) Why is Frenkel defect found in AgCl ?

(b) What is the difference between phosphorus doped and Gallium doped semiconductors ?

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21. Explain the following terms with suitable examples :

(a) Schottky defect

(b) Interstitial defect .

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22. Why are liquids and gases categorised as fluids ?

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23. Why are solids incompressible ?

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24. Give the contribution of the following to the unit cell :

(a) An atom at the corner of a unit cell.

(b) An atom at the middle of a unit cell.

(c) An atom at the centre of face of a unit cell.

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25. (a) How are tetrahedral and octahedral holes formed ?

(b) If N is the number of octahedral holes, what will be the number of tetrahedral holes ?

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26. Inspite of long range order in the arrangement of particles why are the crystals usually not perfect ?

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27. Why does table salt, NaCl, sometimes appear yellow in colour ?

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28. Why is FeO (s) not formed in stoichiometric composition ?

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29. Why does white Zno (s) become yellow upon heating ?

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30. Copper crystallizes into an fec lattice with edge length of 3.61×10^{-8} cm. Calculate the density of copper. $[Given \quad Cu = 63.5 g mol^{-1}, N_A = 6.022 \times 10^{23} mol^{-1}]$

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31. Why does the electrical conductivity of semiconductors increase with rise in temperature ?

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32. In a compound, nitrogen atoms (N) make cubic close packed lattice and metal atoms (M) occupy one third of the tetrahedral voids present. Determine the formula of the compound formed by M and N.

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33. (a) Compare the packing efficiency of square close packing, hexagonal close packing and cubic close packing.

(b) Give the values of packing efficiency in (i) hcp or ccp and (ii) body-centred cubic crystals.

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34. Differentiate between point defects and line defects.

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35. Analysis shows that a metal oxide has the empirical formula $M_{0.98}O_{1.00}$. Calculate the percent- age of M^{2+} and M^{3+} ions in this crystal.

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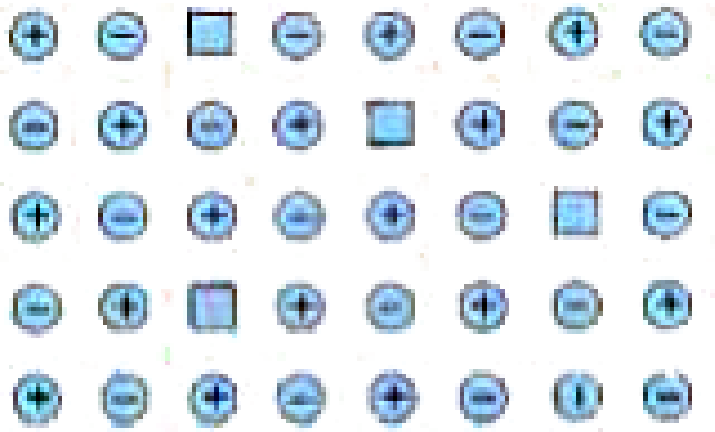
36. Examine the illustration of a portion of the defective crystal given below and answer the following questions :

(i) What are these type of vacancy defects called ?

(ii) How is the density of a crystal affected by these defects ?

(iii) Name one ionic compound which can show this type of defect in the crystalline state.

(iv) How is the stoichiometry of the compound affected ?



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37. In an ionic compound the anion $\left(N^{-}\right)$ form cubic close type of packing, while the cation $\left(M^{+}\right)$ ions occupy one third of the tetrahedral voids. Deduce the empirical formula of the compound and the coordination number of $\left(M^{+}\right)$ ions.

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38. Lithium metal crystal has body-centred cubic structure. Its density is $0.53 gcm^{-3}$ and its molecular mass is $6.94 gmol^{-1}$. Calculate the volume of a unit cell of lithium metal. $\left[NA = 6.023 \times 10^{23} mol^{-1}\right]$

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39. If NaCl crystals are doped with 2×10^{-3} mol per cent of $SrCl_2$, calculate the cation vacancies per mole.

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40. An element having bcc structure has atomic mass 50 u and density $6.81 gcm^{-3}$. Calculate the edge length of the unit cell.

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41. Classify the following solids on the basis of bonding considerations :

CO_2, MgO, Al, H_2, Si, Gd, Pb, $AgCl$.

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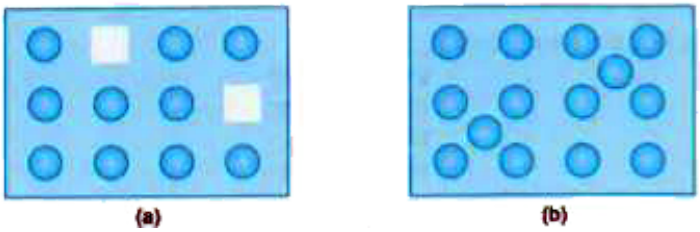
42. Some crystal defects are shown in the figures below :



Indicate the types of defect shown by (a) and (b).

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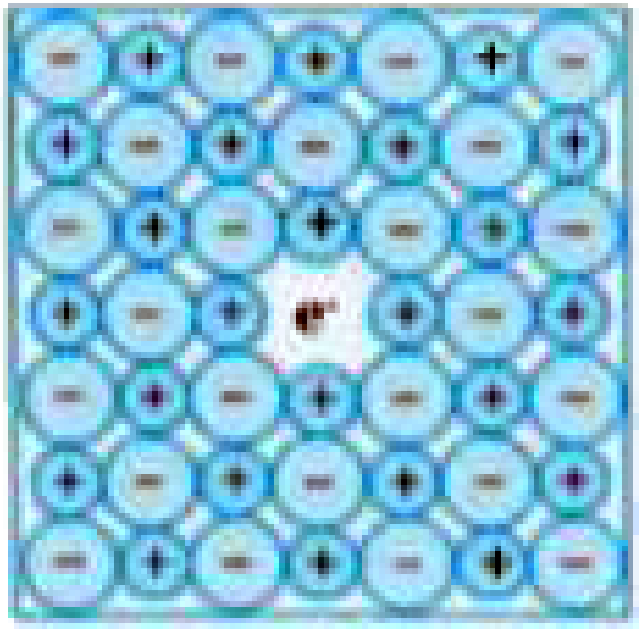
43. The following figure refers to the creation of F-centre.

(i) What type of solids show this type of defect ?

(ii) How are F-centres formed ?



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Long Answer Question I

1. An element with molar mass $27gmol^{-1}$ forms a cubic unit cell with edge length 4.05×10^{-8}cm. If its density is $2.7gcm^{-3}$, what is the nature of cubic unit cell ?

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2. Examine the given defective crystal :

$$\begin{array}{ccccc} X^+ & Y^- & X^+ & Y^- & X^+ \\ Y^- & O & Y^- & X^+ & Y^- \\ X^+ & Y^- & X^+ & O & X^+ \\ Y^- & X^+ & Y^- & X^+ & Y^- \end{array}$$

Answer the following questions :

(i) Is the above defect stoichiometric or non-stoichiometric ?

(ii) Write the term used for this type of defect. Give an example of the compound which shows this type of defect.

(iii) How does this defect affect the density of the solid ?

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3. Examine the given defective crystal :

$X^+ \quad Y^- \quad X^+ \quad Y^- \quad X^+$
$Y^- \quad X^+ \quad Y^- \quad X^+ \quad Y^-$
$X^+ \quad Y^- \quad X^+ \quad e^- \quad X^+$
$Y^- \quad X^+ \quad Y^- \quad X^+ \quad Y^-$

Answer the following questions :

(i) Is the above defect stoichiometric or non-stoichiometric ?

(ii) Write the term used for the electron occupied site.

(iii) Give an example of a compound which shows this type of defect.

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4. Examine the given defective crystal

$X^+ \quad Y^- \quad X^+ \quad Y^- \quad X^+$
$\quad\quad X^+$
$Y^- \quad O \quad Y^- \quad X^+ \quad Y^-$
$X^+ \quad Y^- \quad X^+ \quad Y^- \quad X^+$
$Y^- \quad X^+ \quad Y^- \quad X^+ \quad Y^-$

Answer the following questions :

(i) Is the above defect stoichiometric or non-stoichiometric ?

(ii) Write the term used for this type of defect.

(iii) Why do silver halides show this type of defect ?

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5. Define the following terms :

(i) Primitive unit cell

(ii) Schotty defect

(iii) Ferromagnetism

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6. Define the following terms :

(i) Crystalline solids

(ii) Frenkel defect

(iii) n-type semiconductor.

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7. Define the following terms :

(i) F-centre

(ii) p-type semiconductor

(iii) Ferrimagnetism.

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8. An element with density $11.2 gcm^{-3}$ forms a fcc lattice with edge length of 4×10^{-8} cm. Calculate the atomic mass of the element. $[Given: N_A = 6.022 \times 10^{23} \text{atoms} \quad mol^{-1}]$

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9. (a) What type of semiconductor is obtained when silicon is doped with boron ?

(b) What type of magnetism is shown in the following alignment of magnetic moments ?

$\uparrow \quad \uparrow \quad \uparrow \quad \uparrow \quad \uparrow$

(c) What type of point defect is produced when AgCl is doped with $CdCl_2$?

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10. Iron has a body-centred cubic unit cell with the cell dimension of 286.65 pm. Density of iron is $7.87 gcm^{-3}$. Use this information to calculate Avogadro's number. Atomic mass of Fe = 56.0 u.

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11. The density of lead is $11.35 gcm^{-3}$ and the metal crystallizes with fcc unit cell. Estimate the radius of lead atom. [At. mass of lead = $207 g \quad mol^{-1}$ and $N_A = 6.02 \times 10^{23} mol^{-1}$]

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12. Iron has a body-centred cubic unit cell with a cell edge of 286.65 pm. The density of iron is $7.87 gcm^{-3}$. Use this information to calculate Avogadro's number. [At. mass of Fe = $56 gmol^{-1}$]

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13. An element X with an atomic mass of 60 g/mol has density of $6.23 gcm^{-3}$. If the edge length of its cubic unit cell is 400 pm, identify the type of cubic unit cell. Calculate the radius of an atom of this element.

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14. Differentiate between crystalline and amorphous solids under the following headings :

(a) Melting point

(b) Anisotropy

(c) Order in the arrangement of particles.

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15. (a) What is the significance of the following in crystal structure :

(i) a, b and c (b)

(ii) α, β and γ

(b) What are the values of the above in tetragonal structure ? Give an example of a solid having this structure.

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16. What is a semiconductor ? Describe two main types of semiconductors and explain mechanism for their conduction.

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17. Silver crystallises in an fcc lattice. The edge length of its unit cell is 4.077×10^{-8} cm and its density is $10.5 gcm^{-3}$. Calculate on this basis the atomic mass of silver. $\left[N_A = 6.02 \times 10^{23} mol^{-1}\right]$

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18. Calculate the efficiency [percentage of volume occupied and unoccupied] of packing in case of a metal crystal for simple cubic.

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19. (a) How are tetrahedral and octahedral holes created ?

(b) Is there any difference between cubic closed packed and face-centred cubic structure ? What is the other notation for such structures ?

(c) Which type of substances show Schottky defect ? Give two examples of substances showing this defect.

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20. The nearest neighbouring silver atoms in the silver crystals are 2.87×10^{-10} m apart. What is the density of silver ? Silver crystallises in fcc form. [Atomic mass of Ag = 108]

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Self Assessment Test

1. Choose the wrong option about solids :

A. They have long inter - molecular distance

B. They have definite mass and volume.

C. They are incompressible

D. Inter - molecular forces are strong.

Answer: A

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2. Crystalline solids have the different value of the following property in different directions :

A. electrical resistance.

B. refractive index.

C. electrical resistance and refractive index both.

D. none of these.

Answer: C

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3. Which of the following acts as a solid lubricant ?

A. SnO_2

B. White tin

C. ZnO

D. Graphite

Answer: D

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4. If the total number of atoms per unit cell is 2, the unit cell is

A. primitive cubic.

B. Body centred cubic

C. face-centred cubic.

D. end face-centred.

Answer: B

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5. Density of solid is given by

A. $d = \frac{zM}{a^3 N_A}$

B. $d = \frac{a^3 N_A}{zM}$

C. $d = \frac{za^3}{MN_A}$

D. $d = \frac{zN_A}{a^3 M}$

Answer: A

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6. Assertion (A) : Packing efficiency of hcp and ccp structures is $74\,\%$.

Reason (R) : If the number of close packed spheres is N, then number of tetrahedral voids is N.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: C

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7. Assertion (A) : Each electron in an atom behaves like a tiny magnet.

Reason (R) : Magnetic properties of materials is due to the presence of electrons.

A. Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

B. Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

C. Assertion (A) is correct, but Reason (R) is incorrect statement.

D. Assertion (A) is incorrect, but Reason (R) is correct statement.

Answer: A

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8. An element with density $11.2gcm^{-3}$ forms a fcc lattice with edge length of 4×10^{-8} cm. Calculate the atomic mass of the element. Give $N_A = 6.022 \times 10^{23}$ atoms mol^{-1}.

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