Chemistry Worksheet Class 12 on Chapter 1 Solid State with Answers - Set 1

Q-1: Pure Silicon and Germanium are____.

a) Semiconductors
b) Insulators
c) Conductors
d) None of the above

Answer: b) Insulators

Explanation: Pure Silicon and Germanium do not have freely moving electrons that can jump from the valence band to the conduction band. Hence, these are insulators. However, on treatment with heat, some electrons may jump from the valence band to the conduction band. Hence, they may exhibit semiconductor properties at high temperatures.

Q-2: Among the given crystals, the distance between the cationic and anionic centre is maximum in_____.

a) LiF
b) CsF
c) CsI
d) LiI

Answer: c) CsI

Explanation: This is because both the Cs^+ ion and the I^- ion have the largest ionic radii among the ions present in the given ionic compounds.

Q-3: Which type of a semiconductor is formed when Germanium is doped with Indium?

Answer: Germanium is a group 14 element while Indium is a group 13 element. Hence, an electron deficient hole is created upon the doping of Germanium with Indium. So, this is a p-type semiconductor.

Q-4: LiAg, an intermetallic compound, has both its ions crystallised in the cubic lattice each with a coordination number 8. Which kind of a crystal lattice is this?

a) Face-centred cubic
b) Body centred cubic
c) Simple cubic
d) None of the above

Answer: b) Body centred cubic

Explanation: In a Body centred cubic structure, the coordination number of each of the atoms present is 8.

Q-5: What does an increase in the pressure and temperature do to a solid crystal structure?

Answer: The effect of increasing pressure and temperature on the crystal structure can be explained by the following example: On applying high pressure, the NaCl structure changes its coordination number from 6:6 to 8:8 (resembling the CsCl structure). While on heating upto 760 K, CsCl undergoes a change in its coordination number from 8:8 to 6:6 (resembling the NaCl structure).
Thus, coordination number increases on applying high pressure; while the coordination number decreases on applying heat (raising the temperature).

Q-6: Schottky defect occurs when____.

a) An unequal number of the cations and anions are missing from the crystal lattice.
b) An equal number of cations and anions are missing from the crystal lattice.
c) A cation enters the interstitial site.
d) The density of the crystal is increased.

Answer: b) An equal number of cations and anions are missing from the crystal lattice.

Explanation: In a Schottky defect, an equal number of cations and anions go missing from an A^+B^- crystal lattice. In this defect, the electrical neutrality of the crystal is maintained.

Q-7: Calculate the number of unit cells present in 1g NaCl crystals.

Answer: Mass of 1 mole of NaCl = 58.5 g
NaCl is an ionic compound, then, according to the mole concept, 58.5 g mol^{-1} NaCl contains formula units = 6.02×10^{23} formula units
Hence, 1 g NaCl contains formula units = (6.02×10^{23} formula units / 58.5 g) x 1 g
Now, 4 formula units are contained in unit cells = 1 unit cell
(6.02×10^{23} / 58.5) formula units are contained in unit cells = ¼ x (6.02×10^{23} / 58.5) unit cells
Hence, 1g NaCl crystals contain 2.57×10^{21} unit cells.

Q-8: Calculate the molar mass of an element that occurs in a BCC structure with the cell edge of 250 pm. The density of the element is 8.0 g cm^{-3}.

Answer: Number of particles present per unit cell in a BCC structure (Z) is 2.
Given, the edge of the unit cell is 250 pm i.e. (250×10^{-10}cm) and the density of the element is 8.0 g cm^{-3}.

Substituting the given value in the density expression of a unit cell:

$$Density\ (\rho)\ =\ \frac{Z\ \times\ M}{a^3\ \times\ N_o}$$

Where Z = Number of particles present per unit cell
M = Atomic mass of the element
a = cell width; and N_o = Avagadro's number.
Hence, the molar mass of the element is:

$$8.0\ g\ cm^{-3} = \frac{2\ \times\ M}{(250)^3\ \times\ 10^{-30}\ cm^3 \times\ 6.022\ \times\ 10^{23}\ mol^{-1}}$$

$$M\ =\ 37.64\ g\ mol^{-1}$$

Q-9: Identify the type of defect represented below:

Na^+ Cl^- Na^+ Cl^- Na^+ Cl^-
Cl^- __ Cl^- Na^+ __ Na^+
Na^+ Cl^- __ Cl^- Na^+ Cl^-
Cl^- Na^+ Cl^- Na^+ __ Na^+

a) Schottky Defect
b) Interstitial Defect
c) Schottky Defect and Interstitial Defect
d) Frenkel Defect

Answer: a) Schottky Defect

Explanation: An equal number of cations (Na^+) and anions (Cl^-) are missing from the structure. Hence, this is a Schottky Defect.

Q-10: An element occurring in a FCC arrangement with a cell width of 400 pm has an atomic mass of 60 g mol^{-1}. Calculate the density of the element.

Answer: For a FCC arrangement, Z = 4
Now, from the density formula of the unit cells, we have:

$$Density\ (\rho)\ =\ \frac{Z\ \times\ M}{a^3\ \times\ N_o}$$

Where M = Atomic mass of the element
a = cell width; and N_o = Avagadro's number.
Hence, the density of the element is:

$$\rho\ =\ \frac{4\ \times\ 60\ g\ mol^{-1}}{(400)^3\ \times\ 10^{-30}\ cm^3 \times\ 6.022\ \times\ 10^{23}\ mol^{-1}}$$

$$\rho\ =\ 6.23\ g\ cm^{-3}$$

Q-11: Why does potassium sometimes look violet instead of looking pure white?

Answer: The appearance of colour is due to the presence of electrons at the anionic vacancies. Hence, due to the presence of F-centres, potassium sometimes appears violet in colour.

Q-12: Which defect causes a decrease in the density of the ionic crystal?

Answer: As in the Schottky defect, both- the number of anions and cations are equally reduced from the crystal structure, it reduces the crystal density.

Q-13: State one difference between the properties: Ferromagnetism and Paramagnetism.

Answer: Substances that get attracted by the external magnetic field are called paramagnetic substances and this phenomenon is known as Paramagnetism. While the substances that naturally have permanent magnetism i.e. they show magnetic properties even in the absence of external magnetic field are called ferromagnetic substances. This phenomenon is called Ferromagnetism.

Q-14: What causes the electrical density in ionic solids and semiconductors?

Answer: Electrical conductivity is brought about by moving charges. In ionic solids, the electrical conductivity occurs either due to the flow of the ions (charges) in the solution / molten state or due to the defects in solid structure. However, in semiconductors, the electrical density is brought about by the presence of impurities and/or defects in the crystal lattice.

Q-15: The number of octahedral sites per sphere in a FCC structure is ___.

a) 1
b) 2
c) 4
d) 8

Answer: a) 1

Explanation:The number of octahedral sites is equal to the number of ions present in the packaging. Hence, the number of octahedral sites per sphere in a FCC structure is 1.

Q-16: The formula of Nickel oxide is $Ni_{0.98}O$. In what fractions do the Ni^{2+} and Ni^{3+} ions exist in the crystal lattice?

Answer: From the given formula of Nickel oxide, it is understood that 98 atoms of Ni are associated with 100 atoms of oxygen.
Let us assume the number of Ni^{2+} ions present = x and the number of Ni^{3+} ions present = $(98 - x)$.

As $Ni_{0.98}O$ is a neutral molecule, the sum of the charges on both the Ni ions must be equal to the total charge on oxygen.
Hence, the charge due to 98 ions of Ni (Ni^{2+} and Ni^{3+}) = charge due to 100 O^{2-} ions
∴ (charge x number) Ni^{2+} ions + (charge x number) Ni^{3+} ions = (charge x number) O^{2-} ions
$2x + 3(98 - x) = 2 \times 100$
Hence, x = number of Ni^{2+} ions = 94 and $(98 - x)$ = number of Ni^{3+} ions = 4
Fraction of Ni^{2+} ions = (94/98) x 100 = 96%
Fraction of Ni^{3+} ions = (4/98) x 100 = 4%

Q-17: The density of the crystal remains unchanged by ____.

a) Schottky defect
b) Interstitial defect
c) Frenkel defect
d) All of the above

Answer: c) Frenkel defect

Explanation: In a Frenkel defect, a cation leaves a lattice site to occupy the interstitial site. Hence, the density remains unchanged.

Q-18: Give reason for the following:
$CaCl_2$ added to AgCl crystal introduces the Schottky defect.

Answer: Ag has 1 unit positive charge and Ca has 2 units positive charge. So, when $CaCl_2$ is introduced into the AgCl crystal (doping), two Ag^+ ions get replaced by only 1 Ca^{2+} ion in order to maintain the electrical neutrality. Thus, 1 hole is created for every Ca^{2+} ion introduced into the AgCl crystal.

Q-19: With which group's element must a group 14 element be doped in order to obtain a n-type semiconductor?

Answer: In an n-type semiconductor, the conductance arises due to an excess of electrons. Hence, in order to convert a group 14 element into n-type semiconductor, it must be doped with an element of group 15.

Q-20: Distinguish between the hexagonal and monoclinic unit cells.

Answer: The relation between the edges of a Hexagonal unit cell: $a = b \neq c$. The relation in between the angles in between the edges of the hexagonal unit cell: $\alpha = \beta = 90^o$; $\gamma = 120^o$.

While the relation between the edges of a monoclinic unit cell: $a \neq b \neq c$. The relation in between the angles in between the edges of the monoclinic unit cell: $\alpha = \gamma = 90^o$; $\beta \neq 90^o$.