SOLID STATE - 2

Density, Bragg's Equation, Crystal Defects and Properties of solids

1) Density of a crystal is given by:

1) $\frac{a^3 \times M}{z \times N_o}$ 2) $\frac{z \times M}{a^3 \times N_o}$ 3) $\frac{N_o \times M}{z \times a^3}$ 4) $\frac{a^3 \times N_o}{z \times M}$

2) An element crystallizes in a structure having F.C.C. unit cell of an edge 200 pm. Calculate the density if 200 gm of it contains 24×10^{23} atoms

1) 41.6 gm/cm^3 2) 42.6 gm/cm^3 3) 43.6 gm/cm^3 4) 44.6 gm/cm^3

HINT: Mass of 24×10^{23} atoms=200gm, Mass of $6X10^{23}$ atoms (M)=50gm

$\rho = \frac{ZM}{N_0.a^3}$ =4X50/6X10^{23}X (200X10^{-10})^3 =41.6 gm/cm^3

3) A metal crystallizes in two cubic phases, fcc and bcc whose unit cell lengths are 2^0A and $3\ ^0$A respectively. The ratio of density of fcc and bcc is

1) 1.5 2) 3.375 3) 13.5 4) 6.75

Hint: $\frac{\rho_1}{\rho_2} = \frac{z_1}{z_2}.\frac{(a_2)^3}{(a_1)^3} = \frac{4}{2}$ X$3^3/2^3$=6.75

4) Ice crystallizes in a hexagonal lattice having volume of the unit cell as $132 \times 10^{-24}\ cm^3$. If density is 0.92g at a given temperature, then number of H_2O molecules per unit cell is

1) 1 2) 2 3) 3 4) 4

Hint; $z = \frac{\rho.N_0.V}{M} = \frac{132 \times 10^{-24}\ X\ 6X10^{23}\ X\ 0.92}{18}$ =4

5) A metal crystallizes as body centered cubic lattice with the edge length of unit cell equal to 0.304 nm. If the molar mass of the metal is $50.3\ g\ mol^{-1}$, its density is

1) $5.945\ g\ cm^{-3}$ 2) $2.9725\ g\ cm^{-3}$

3) $8.9175\ g\ cm^{-3}$ 4) $4.458\ g\ cm^{-3}$

Hint: $\rho = \frac{ZM}{N_0.a^3}$, here z = 2, a = 0.0304 X 10^{-7} cm

6) **A element 'X' crystallizes as face centered cubic lattice with edge length of 460 pm. The density of the element X, when molar mass of X atom is 60 gm/mol is**

1) 4.096 **gm/mol** 2) 2.048 **gm/mol** 3) 6.144 **gm/mol** 4) 3.072 **gm/mol**

Hint: $\rho = \frac{ZM}{N_0.a^3}$, here z=4 ,a=460X10^{-10}=4.6X10^{-8}

7) **If the density of** $NaCl = 2.165\, g\, cm^{-3}$ **and the distance between** Na^+ **and** $Cl^- = 281\, pm$**, Avogadro's number is equal to**

1) $7\times10^{23}\, mol^{-1}$ 2)8X10^{23}mol^{-1} 3) 6X10^{23}mol^{-1} 4) 3X10^{23}mol^{-1}

8) **The ratio of 'd' values in NaCl crystal is**

1) 0.703:1:1.134 2) 1:1.34:0:703 3) 1:0.703:1.134 4) 0.703:1.134:1

9) **The second order Bragg diffraction of X-rays with** $\lambda = 1.00$ **Å from a set of parallel planes in a metal occurs at an angle of 60°. The distance between the scattering planes in the crystal is**

1) 0.575 Å 2) 1.00 Å 3) 2.00 Å 4) 1.15 Å

Hint: $n\lambda = 2d\sin\theta$, d= 2X1/2Xsin60=1/sin60= 2/$\sqrt{3}$=1.15

10) **From Bragg's equation which one of the following is wrong?**

1) Incident angle value is in between 0 to 90^0

2) Order of diffraction 'n' is an integer

3) $2d < n\lambda$

4) As λ of x-rays increases, incident angle for first order diffraction increases

11) **At what angle for a first order diffraction, the distance between two adjacent planes of crystal is equal to the wavelength of X-rays used**

1) 45^0 2) 30^0 3) 90^0 4) 60^0

HINT: AS d= λ, sinθ=1/2 i.e. θ=30

12) **If two waves with the amplitude 'a' of each undergo constructive interference, the amplitude of the resulting wave is**

1) 0 2)2a 3)<2 a 4) a^2

13) **Schottky defect causes**

1) Increase in the density of solid

2) Decrease in the density of solid

3) No change in the density of solid

4) Decrease in the conductivity of solid.

14) What type of crystal defect is indicated in the diagram below

1) Frenkel defect

2) Frenkel and Schottky defects

3) Interstitial defect

4) Schottky defect

15) Schottky - Wagner defects are mostly found in

1) Ionic compounds with high co-ordination number

2) Ionic compound with low co-ordination number

3) Covalent compounds with low coordination number

4) Covalent compound with high coordination number

16) Which among the following is likely to have Schottky defect?

1) Ag Cl 2) NaCl 3) TiCl 4) $MgCl_2$

17) A: During vacancy defect the density of solid decreases

R: The vacancies in the lattice lower the density of solid

18) Schottky defect in crystals is observed when

1) Unequal number of cations and anions are missing from the lattice

2) Equal number of cations and anions are missing from the lattice

3) An ion leaves its normal site and occupies an interstitial cells

4) Density of the crystal is increased

19)

List - I	**List - II**
A) Crystal defect	**1) Amorphous**
B) Carborundum	**2) Frenkel**
C) Pitch	**3) Covalent crystal**

The correct match is

	A	B	C		A	B	C
1)	3	1	2	2)	2	1	3
3)	2	3	1	4)	1	2	3

20) Which of the following is a "Berthollide Compound'?

1) MgO 2) Al_2O_3 3) Na_2O 4) ZrH_2

21) The formula of an oxide of iron is $Fe_{0.93}O_{1.00}$. If the compound has hundred O^{-2} ions, then it contains

1) $93Fe^{+2}ions$ 2) $93Fe^{+3}ions$ 3) $79Fe^{+2},14Fe^{+3}$ 4) $93Fe^{+2},14Fe^{+3}$

Solution; Let the sample contains 93 iron ions & 100 oxide ions

Total negative charge on oxide ions =100 X -2=-200

No of Fe^{+3} ions = X

No of Fe^{+2} ions = 93-x

Total positive charge = x(+3)+(93-x)(+2)

Numerically +ve charge and -ve charge are equal

Thus 3x+(93-x)2=200

x=14

22) To get n-type semiconductor, impurity to be added to silicon should have the following number of valence electrons

1) 2 2) 3 3) 1 4) 5

23) (A): With increase in temperature the conductivity of metals decreases.

(R): with increase in temperature lattice vibrations increases in metals.

24) The mechanism of electrical conductivity may be given in terms of

1) Vacancy mechanism

2) Interstitial mechanism

3) Interstitially mechanism

4) All

25) A: Metals are generally good conductors of electricity

R: Electrical conductivity of metals is due to Schottky type defects

26). In which of the following the conductivity would be in the order of 10^{-4} ohm^{-1} cm^{-1}

1) $NaCl_{(s)}$ 2) $Na_{(s)}$

3) Diamond 4) Ge

27). Which one of the following ratio gives the purity of the metal (-resistivity (or) specific resistance)

1) $\frac{\rho_{300^0C}}{\rho_{4.2^0C}}$ 2) $\frac{\rho_{300K}}{\rho_{4.2K}}$ 3) $\frac{\rho_{27K}}{\rho_{4K}}$ 4) $\frac{\rho_{300K}}{\rho_{4^0C}}$

28) Germanium can be made n-type semi conductor by doping with

1) silicon 2) arsenic

3) gallium 4) either As (or) Ga

29. Which one of the following statements is wrong?

1) With increasing the temperature the electrical conductivity of Germanium decreases

2) Silicon doped with phosphorus is n-type semi conductor

3) Germanium doped with indium is p-type semi conductor

4) Doping increases the conductivity of semi conductor

30) The magnetic susceptibility of a substance can be expressed as

1) gram susceptibility

2) volume susceptibility

3) molar susceptibility

4) all

31) A: Antiferromagnetic substances possess almost zero magnetic moment

R: There are no unpaired electrons in antiferromagnetic substances

32) Which of the following is correct statement?

1)silicon doped with boron is n-type semiconductor

2)silicon doped with arsenic is a p-type semiconductor

3)metals are good conductors of electricity

4) electrical conductivity of semiconductors decreases with increasing temperature

33) The general formula of ferrites is MFe_2O_4. Where 'M' would not be

1) Mg 2) Cu 3) Al 4) Zn

34) A: $K_4[Fe(CN)_6]$ is diamagnetic

R: The alignments of magnetic dipoles are in compensatory to give zero magnetic moment

35) Which substance shows anti ferro magnetism?

1) ZrO_2 2) CdO3) CrO_2 4) V_2O_3

36) A: Fe_3O_4 is ferromagnetic at room temperature but becomes paramagnetic at 850 K

R: The magnetic moments in Fe_3O_4 are aligned equally in parallel and antiparallel directions which on heating randomise

37) The alignment of magnetic dipoles shown below represents which of the following?

↑ ↓ ↓ ↑ ↓ ↓

1) Diamagnetism
2) Ferri magnetism
3) Ferro magnetism
4) Anti-ferromagnetism

38)

List - I	**List - II**
A) Antiferromagnetic	**1) $ZnFe_2O_4$**
B) Covalent crystal	**2) NiO**
C) Ferrimagnetic	**3) Diamond**

The correct match is

	A	B	C		A	B	C
1)	2	3	1	2)	3	2	1
3)	1	2	3	4)	1	3	2

39) Which one of the following is correct?

1) Schottky defect lowers the density
2) Frenkel defect increases the dielectric constant of the crystals
3) Stoichiometric defects make the crystals good electrical conductors
4) All of these

40) At zero Kelvin, most of the ionic crystals possess

1) No defect
2) Frenkel defect
3) Schottky defect
4) Metal excess defect

41) (A): Schottky and Frenkel defects are also called as 'thermodynamic defects'

(R): Both schottky and frenkel defects increases with increase in temperature

1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true but (R) is not the correct explanation of (A)
3) (A) is true but (R) is false. 4) Both (A) and (R) are false.

42) The electrical conductivity of semiconductors

1) Increases with temperature

2) Decreases with temperature

3) Remains constant on heating

4) All the above

43) Which substance will conduct the current in the solid state?

1) Diamond 2) Graphite

3) Iodine 4) Sodium chloride

44) To get p-type doped semiconductor, impurity to be added to silicon should have the following number of valence electrons

1) 1 2) 2 (3) 3 (4) 5

45) A diode is

1) npn or pnp type of semi conductor

2) only n type of semi conductor

3) only p type of semi conductor

4) only npn type of semi conductor

46) Ferromagnetism is maximum in

1) Fe 2) Co 3) Ni 4) equal in all

47) Assertion (A): Electrical conductivity of semiconductors increases with increasing temperature

Reason (R): With increase in temperature, large number of electrons from the valence band can jump to the conduction band.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true but (R) is not the correct explanation of (A)

3) (A) is true but (R) is false.

4) Both (A) and (R) are false.

48) Assertion (A): Fe_3O_4 is ferrimagnetic at room temperature but becomes paramagnetic at 850K

Reason (R): The magnetic moments in are aligned equally in parallel and antiparallel directions which on heating randomise

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true but (R) is not the correct explanation of (A)

3) (A) is true but (R) is false.

4) Both (A) and (R) are false.

49) **X-rays of wavelength equal to 1.134nm give a first order diffraction from the surface of a crystal when the value of θ is10.5^0 , then the distance between the adjacent plane in the crystal is(sin10.5^0 =0.1822)**

1) 367mn 2) 0.367nm

3) 3.67nm 4) 0.0367 nm

Hint; 2d Sinθ=nλ

50) **In a diffraction experiment, x-rays of wavelength 0.14nm were used on a crystal. 'n' is the order of diffraction that occurs at an angle of θ**is 19.5^0**. If the interplanar distance is 4.42nm n value is (sin** 19.5^0**= 0.333)**

1) 2 2) 1 3) 3 4) 4

Hint; 2d Sinθ=nλ

ANSWERS

1) 4	2) 2	3) 4	4) 4	5) 1	6) 1	7)3	8)3	9)4	10)3
11) 2	12)2	13)2	14)4	15) 1	16) 2	17) 1	18) 2	19) 3	20) 4
21) 3	22) 4	23) 1	24) 4	25) 3	26) 4	27) 2	28) 2	29) 1	30) 4
31) 3	32) 3	33) 3	34) 3	35) 4	36) 3	37) 2	38) 1	39)4	40)1
41) 4	42) 1	43) 2	44) 3	45) 1	46) 1	47)1	48)1	49)2	50)1