Chemistry Extra Questions

18. Define the terms: Osmosis and osmotic pressure. Is the osmotic pressure of a solution a colligative property? Explain. **Delhi 2011**

19. What is van't Hoff factor? What possible values can it have if the solute molecules undergo dissociation? **Delhi 2011C**

20. The molecular masses of polymers are determined by osmotic pressure method and not by measuring other colligative properties. Give two reasons. **All India 2011C**

21. Define the terms osmosis and osmotic pressure. What is the advantage of using osmotic pressure as compared to other colligative properties for the determination of molar masses of solutes in solutions? **All India 2010**

22. Find the boiling point of a solution containing 0.520 g of glucose ($C_6H_{12}O_6$) dissolved in 80.2 g of water. [Given, K_b for water = 0.52 Km^{-1}] . **All India 2010C**

23. Find the freezing point of a solution containing 0.520 g glucose ($C_6H_{12}O_6$) dissolved in 80.2 g of water [Given, K_f for water = 1.86 Km^{-1}] . **All India 2010C**

24. Outer hard shells of two eggs are removed one of the egg is placed in pure water and the other is placed in saturated solution of sodium chloride. What will be observed and why? **All India 2010C**

25. The depression in freezing point observed for the same molar concentrations of acetic acid, trichloroacetic acid and trifluoroacetic acid increases in the order as stated above. Explain. **Delhi 2008C**

3 Marks Questions

26. A 10% solution (by mass) of sucrose in water has freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water, if freezing point of pure water is 273.15 K.
Given : Molar mass of sucrose = 342 g mol^{-1} and Molar mass of glucose = 180 g mol^{-1} **Delhi 2017**

27. Calculate the boiling point of solution when 4 g of $MgSO_4$ (M = 120 g mol^{-1}) was dissolved in 100 g of water assuming $MgSO_4$ undergoes complete ionisation. (K_b for water = 0.52 K kg mol^{-1}) **All India 2016**

28. Calculate the mass of NaCl (molar mass = 58.5 g mol^{-1}) to be dissolved in 37.2 g of water to lower the freezing point by 2°C, assuming that NaCl undergoes complete dissociation. (K_f for water = 1.86 K kg mol^{-1}) **Foreign 2015**

Or What mass of NaCl must be dissolved in 65.0 g of water to lower the freezing point of water by 7.50°C? The freezing point depression constant (K_f) for water is 1.86°C/m. Assume van't Hoff factor for NaCl is 1.87. (molar mass of NaCl = 58.5 g mol^{-1}). **All India 2011, 2010; Foreign 2010**

29. 45 g of ethylene glycol ($C_2H_6O_2$) is mixed with 600 g of water. Calculate
(i) the freezing point depression and
(ii) the freezing point of the solution.
(Given, K_f of water = 1.86 K kg mol^{-1}) **Delhi 2015C**

30. A 5% solution (by mass) of cane sugar ($M \cdot W$ 342) is isotonic with 0.877% solution of substance X. Find the molecular weight of X. **HOTS; All India 2015C**

31. 3.9 g of benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the van't Hoff factor and predict the nature of solute (associated or dissociated).
(Given : Molar mass of benzoic acid = 122 g mol^{-1}, K_f for benzene = 4.9 K kg mol^{-1}) **Delhi 2015**

32. A solution is prepared by dissolving 10 g of non-volatile solute in 200 g of water. It has a vapour pressure of 31.84 mm of Hg at 308 K. Calculate the molar mass of the solute.

(Vapour pressure of pure water at 308 K = 32 mm Hg) **All India 2015**

33. Calculate the boiling point elevation for a solution prepared by adding 10 g of $CaCl_2$ to 200 g of water.
(K_b for water = 0.512 K kg mol^{-1}, molar mass of $CaCl_2$ = 111 g mol^{-1}). **Foreign 2014**

34. Some ethylene glycol, $HOCH_2CH_2OH$, is added to your car's cooling system along with 5 kg of water. If the freezing point of water-glycol solution is –15.0°C, what is the boiling point of the solution?
(K_b = 0.52 K kg mol^{-1} and K_f = 1.86 K kg mol^{-1} for water) **Delhi 2014C**

35. Determine the osmotic pressure of a solution prepared by dissolving 2.5×10^{-2} g of K_2SO_4 in 2 L of water at 25°C, assuming that it is completely dissociated.
(R = 0.0821 L atm K^{-1} mol^{-1}, molar mass of K_2SO_4 = 174 g mol^{-1}). **Delhi 2013**

36. 1.00 g of a non-electrolyte solute when dissolved in 50 g of benzene lowered the freezing point of benzene by 0.40 K. Find the molar mass of the solute. (K_f for benzene = 5.12 K kg mol^{-1}) **All India 2013**

37. A 5% solution (by mass) of cane-sugar in water has freezing point of 271 K. Calculate the freezing point of 5% solution (by mass) of glucose in water if the freezing point of pure water is 273.15 K.
[Molecular masses glucose ($C_6H_{12}O_6$) = 180 amu or g mol^{-1} and cane-sugar ($C_{12}H_{22}O_{11}$) = 342 amu or g mol^{-1}]
All India 2013C, Foreign 2008

38. At 25°C, the saturated vapour pressure of water is 3.165 k Pa (23.75 mm Hg). Find the saturated vapour pressure of a 5% aqueous solution of urea (carbamide) at the same temperature. (Molar mass of urea = 60.05 g mol^{-1}). **Foreign 2012**

39. 15.0 g of unknown molecular material is dissolved in 450 g of water. The resulting solution freezes at – 0.34°C. What is the molar mass of the material?
(K_f for water = 1.86 K kg mol^{-1}).
All India 2012, 2010

40. A solution of glycerol ($C_3H_8O_3$) in water was prepared by dissolving some glycerol in 500 g of water. This solution has a boiling point of 100.42°C, what mass of glycerol was dissolved to make this solution?
(K_b for water = 0.512 K kg mol^{-1}).
All India 2012; Delhi 2012, 2010

41. Calculate the freezing point of an aqueous solution containing 10.50 g of $MgBr_2$ in 200 g of water (molar mass of $MgBr_2$ = 184 g mol^{-1}, K_f for water is 1.8 K kg mol^{-1}). **Delhi 2011**

42. Calculate the boiling point of a solution prepared by adding 15.00 g of NaCl to 250.0 g of water. (K_b for water = 0.512 K kg mol^{-1}, molar mass of NaCl = 58.44 g mol^{-1}). **Delhi 2011**

43. What would be the molar mass of a compound if 6.21 g of it dissolved in 24.0 g of chloroform form a solution that has boiling point of 68.04°C. The boiling point of pure chloroform is 61.7°C and the boiling point elevation constant, K_b for chloroform is 3.63°C/m. **Delhi 2011**

44. A solution prepared by dissolving 8.95 mg of a gene fragment in 35.0 mL of water has an osmotic pressure of 0.335 torr at 25°C. Assuming the gene fragment is non-electrolyte, determine its molar mass. **Delhi 2011; All India 2011**

45. A 0.561 m solution of unknown electrolyte depresses the freezing point of water by 2.93°C. What is van't Hoff factor for this electrolyte? The freezing point depression constant (K_f) for water is 1.86°C kg mol^{-1}. **Foreign 2011**

46. Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20 g of phenol in 1.0 kg of benzene has its freezing point lowered by 0.69 K. Calculate the fraction of phenol that has dimerised.
(Given, K_f for benzene = 5.1 K kg mol^{-1}).
HOTS; Delhi 2011C

47. An aqueous solution containing 12.48 g of barium chloride in 1.0 kg of water boils at 373.0832 K. Calculate the degree of dissociation of barium chloride.
(Given, K_b for H_2O = 0.52 K kg mol^{-1}, molar mass of $BaCl_2$ = 208.34 g mol^{-1}). **Delhi 2011C**

48. At 300 K, 36 g of glucose, $C_6H_{12}O_6$ present per litre in its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of another glucose solution is 1.52 bar at the same temperature, calculate the concentration of the other solution. **HOTS; All India 2011C**

49. Calculate the boiling point of one molar aqueous solution. Density of KBr solution is 1.06 g mL^{-1} (K_b for H_2O = 0.52 K kg mol^{-1}, atomic mass of K = 39, Br = 80).
HOTS; All India 2011C

50. A solution prepared by dissolving 1.25 g of oil of wintergreen (methyl salicylate) in 99.0 g of benzene has a boiling point of 80.31°C. Determine the molar mass of this compound.
(Boiling point of pure benzene = 80.10°C and K_b for benzene = 2.53°C kg mol^{-1}).
Delhi 2010; Foreign 2010

51. What mass of ethylene glycol (molar mass 62.0 g mol^{-1}) must be added to 5.50 kg of water to lower the freezing point of water from 0°C to – 10.0°C?
(K_f for water = 1.86 K kg mol^{-1}). **All India 2010**

52. 0.1 mole of acetic acid was dissolved in 1 kg of benzene. Depression in freezing point of benzene was determined to be 0.256 K. What conclusion can you draw about the state of the solute in solution?
(Given, K_f for benzene = 5.12 K kg mol^{-1}).
Delhi 2010C

53. Calculate the mass of ascorbic acid ($C_6H_8O_6$) to be dissolved in 75 g of acetic acid to lower its melting point by 1.5°C (K_f for acetic acid is 3.9 K kg mol^{-1}).
All India 2010C

54. 100 mg of a protein is dissolved in just enough water to make 10.0 mL of solution. If this solution has an osmotic pressure of 13.3 mm Hg at 25°C, what is the molar mass of the protein?
(R = 0.0821 L atm mol^{-1} K^{-1} and 760 mm Hg = 1 atm). **Delhi 2009; All India 2009**

55. Calculate the freezing point depression expected for 0.0711 m aqueous solution of Na_2SO_4. If this solution actually freezes at – 0.320°C, what would be the value of van't Hoff factor? (K_f for water is 1.86°C kg mol^{-1}). **Delhi 2009; Foreign 2009**

56. Calculate the freezing point of a solution containing 18 g glucose, $C_6H_{12}O_6$ and 68.4 g sucrose, $C_{12}H_{22}O_{11}$ in 200 g of water. The freezing point of pure water is 273 K and K_f for water is 1.86 K kg mol^{-1}. **HOTS; All India 2009C**

57. Calculate the temperature at which a solution containing 54 g of glucose ($C_6H_{12}O_6$) in 250 g of water will freeze.
(K_f for water = 1.86 K kg mol^{-1} and molar mass of glucose = 180 g mol^{-1}).
Delhi 2008; All India 2008; Foreign 2008

58. A solution containing 8 g of a substance in 100 g of diethyl ether boils at 36.86°C, whereas pure ether boils at 35.60°C. Determine the molecular mass of the solute (for ether, K_b = 2.02 K kg mol^{-1}).
All India 2008; Foreign 2008

59. Calculate the mass of a non-volatile solute (molar mass = 40 g mol^{-1}), which should be dissolved in 114 g of octane to reduce its vapour pressure to 80%. (Molar mass of octane = 114 g mol^{-1}). **Foreign 2008**

60. The boiling point elevation of 0.30 g acetic acid in 100 g benzene is 0.0633 K. Calculate the molar mass of acetic acid

62. (i) A 10% solution (by mass) of sucrose in water has a freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water if the freezing point of pure water is 273.15 K.

(Given,
molar mass of sucrose = 342 g mol^{-1}
and molar mass of glucose = 180 g mol^{-1})

(ii) Define the following terms :

(a) Molality (m)

(b) Abnormal molar mass

All India 2017

63. (i) Calculate the freezing point of solution when 1.9 g of $MgCl_2$ (M = 95 g mol^{-1}) was dissolved in 50 g of water, assuming $MgCl_2$ undergoes complete ionisation. (K_f for water = 1.86 K kg mol^{-1})

(ii) (a) Out of 1 M glucose and 2 M glucose, which one has a higher boiling point and why?

(b) What happens when the external pressure applied becomes more than the osmotic pressure of the solution? **Delhi 2016**

64. (i) When 2.56 g of sulphur was dissolved in 100 g of CS_2, the freezing point lowered by 0.383 K. Calculate the formula of sulphur (S_x).

PREVIOUS YEARS' EXAMINATION QUESTIONS

TOPIC 3

1 Mark Questions

1. What are isotonic solutions? All India 2014, 12
2. Define the term osmotic pressure. All India 2013; Delhi 2010C, 2009C
3. What is meant by reverse osmosis? All India 2013, 2011; Foreign 2009
4. Define the following terms.
   (i) Isotonic solutions
   (ii) van't Hoff factor Delhi 2012; All India 2012
5. Explain boiling point elevation constant for a solvent or ebullioscopic constant. All India 2012 ; Foreign 2012
6. Define the term van't Hoff factor. All India 2009
7. What is meant by colligative properties? All India 2009

2 Marks Questions

8. Define the following terms:
   (i) Colligative properties
   (ii) Molality (m) Delhi 2017
9. Define the following terms:
   (i) Abnormal molar mass
   (ii) van't Hoff factor Delhi 2017
10. Define osmotic pressure of a solution. How is the osmotic pressure related to the concentration of a solute in a solution? Delhi 2015C

Or Define the term osmotic pressure. Describe how the molecular mass of a substance can be determined by a method based on measurement of osmotic pressure? Delhi 2008; All India 2008; Foreign 2008

11. (i) On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution? What change in temperature would you observe after mixing liquids X and Y?
    (ii) What happens when we place the blood cell in water (hypertonic solution)? Give reason. All India 2015
12. Why does a solution containing non-volatile solute have higher boiling point than the pure solvent? Why is elevation of boiling point a colligative property? All India 2015
13. Calculate the mass of compound (molar mass = 256 g mol^{-1}) to be dissolved in 75 g of benzene to lower its freezing point by 0.48 K(K_f = 5.12 K kg mol^{-1}). All India 2014
14. How is the vapour pressure of a solvent affected when a non-volatile solute is dissolved in it? Delhi 2014C

Or State how the vapour pressure of a solvent is affected when a non-volatile solute is dissolved in it? Foreign 2008

15. An aqueous solution of sodium chloride freezes below 273 K. Explain the lowering in freezing point of water with the help of a suitable diagram. Delhi 2013C
16. 18 g glucose, $C_6H_{12}O_6$ (molar mass = 180 g mol^{-1}) is dissolved in 1 kg of water in a sauce pan. At what temperature, will this solution boil?
    (K_b for water = 0.52 K kg mol^{-1}, boiling point of pure water = 373.15 K). Delhi 2013
17. A 1.00 molal aqueous solution of trichloroacetic acid (CCl_3COOH) is heated to its boiling point. The solution has the boiling point 100.18°C. Determine the van't Hoff factor for trichloroacetic acid.
    (K_b for water = 0.512 K kg mol^{-1}). Delhi 2012

3. Write the type of magnetism observed when the magnetic moments are aligned in parallel and anti-parallel directions in unequal numbers. **All India 2014**

4. What type of stoichiometric defect is shown by NaCl? **Delhi 2014C**

5. What is meant by anti-ferromagnetism? **All India 2014C**

6. What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic? **Delhi 2013**

7. What are n-type semiconductors? **All India 2012**

8. What is meant by 'doping' in a semiconductor? **Delhi 2012**

9. How may the conductivity of an intrinsic semiconductor be increased? **All India 2012**

10. Which stoichiometric defect (point defect) in crystals increases the density of a solid? **All India 2012; Delhi 2011, 2009**

11. What is meant by the term forbidden zone in reference to band theory of solids? **Foreign 2012**

12. What type of stoichiometric defect is shown by AgBr and AgI? **All India 2012**

13. What type of defect can arise when a solid is heated? **All India 2012C**

14. What is meant by intrinsic semiconductor? **Foreign 2011**

15. Which point defect in crystals of a solid does not change the density of the solid? **Delhi 2010, 2009**

16. Which point defect in crystals of a solid decreases the density of the solid? **Delhi 2010; All India 2009; Foreign 2009**

17. What type of semiconductor is obtained when silicon is doped with arsenic? **All India 2010**

18. Give an example of an ionic compound which shows Frenkel defect. **All India 2010C**

19. Why is Frenkel defect not found in pure alkali metal halides? **All India 2010C**

20. Which point defect in its crystal units alters the density of a solid? **Delhi 2009**

21. What type of substances exhibit anti-ferromagnetism? **Delhi 2008**

22. What type of alignment in crystals makes them ferromagnetic? **Foreign 2008**

23. Name an element with which silicon should be doped to give n-type semiconductor. **Delhi 2008C**

24. What are F-centres? **All India 2008C**

2 Marks Questions

25. (i) Write the type of magnetism observed when the magnetic moments are oppositely aligned and cancel out each other.
(ii) Which stoichiometric defect does not change the density of the crystal? **Delhi 2014 or All India 2014 (ii)**

26. Examine the given defective crystal.

A^+	B^-	A^+	B^-	A^+
B^-		B^-	A^+	B^-
A^+	B^-	A^+		A^+
B^-	A^+	B^-	A^+	B^-

Answer the following questions.
(i) What type of stoichiometric defect is shown by the crystal?
(ii) How is the density of the crystal affected by this defect?
(iii) What type of ionic substances show such defect? **All India 2014; Delhi 2014**

27. (i) What type of non-stoichiometric point defect is responsible for the pink colour of LiCl?
(ii) What type of stoichiometric defect is shown by NaCl? **Delhi 2014**

28. (i) What type of stoichiometric defect is shown by KCl and why?
(ii) What type of semiconductor is formed when silicon is doped with As?
(iii) Which one of the following is an example of molecular solid?
CO_2 or SiO_2
(iv) What type of substance would make better magnets, ferromagnetic or ferrimagnetic? **Foreign 2014**

29. (i) Why does the presence of excess of lithium makes LiCl crystal pink?

(ii) A solid with cubic crystal 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?
All India 2013

30. Account for the following.

(i) Schottky defects lower the density of related solids.

(ii) Conductivity of silicon increases on doping it with phosphorus.
All India 2013

31. (i) What change occurs when AgCl is doped with $CdCl_2$?

(ii) What type of semiconductor is produced when silicon is doped with boron? All India 2013

32. If NaCl is doped with 10^{-3} mole percent $SrCl_2$, What will be the concentration of cationic vacancies?
($N_A = 6.02 \times 10^{23}$ mol^{-1})
All India 2013C

33. Explain the following terms with suitable example of each.

(i) Ferromagnetism

(ii) Anti-ferromagnetism Delhi 2011C

34. In terms of band theory, explain the difference between a conductor and a semiconductor and give one suitable example for each. All India 2011C

35. How are the following properties of crystals affected by Schottky and Frenkel defects?

(i) Density

(ii) Electrical conductivity Delhi 2010, 2009C

36. Explain the following terms with one suitable example of each. Delhi 2010C

(i) Ferromagnetism

(ii) Paramagnetism

37. Describe the two main types of semiconductors and contrast their conduction mechanism. All India 2009C

3 Marks Questions

38. (i) Based on the nature of intermolecular forces, classify the following solids.
Silicon carbide, argon

(ii) ZnO turns yellow on heating. Why?

(iii) What is meant by groups 12-16 compounds? Give an example.
All India 2017

39. (i) Based on the nature of intermolecular forces, classify the following solids.
Sodium sulphate, hydrogen

(ii) What happen when $CdCl_2$ is doped with AgCl?

(iii) Why do ferrimagnetic substances show better magnetism than antiferromagnetic substances?
All India 2017

40. 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 crystal? All India 2015

41. Define the following:

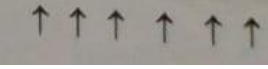
(i) Schottky defect

(ii) Frenkel defect

(iii) F-centres Delhi 2015

42. (i) What type of semiconductor is obtained when silicon is doped with boron?

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



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

All India 2013

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

Delhi 2008, 2008C; All India 2008, 2008C

44. How would you account for the following?

(i) Frenkel defects are not found in alkali metal halides.

(ii) Schottky defects lower the density of related solids.

(iii) Impurity doped silicon is a semiconductor. Delhi 2008

45. Explain the following properties giving suitable examples.

(i) Ferromagnetism

(ii) Paramagnetism

(iii) Ferrimagnetism

Delhi 2008; Foreign 2008

46. Explain the following giving a suitable example in each case.

(i) Frenkel defect

(ii) *F*-centres

(iii) Paramagnetism Foreign 2008

47. Explain the following terms with suitable examples.

(i) Schottky defect

(ii) Ferromagnetism Delhi 2008C

48. Account for the following:

(i) Fe_3O_4 is ferrimagnetic at room temperature but becomes paramagnetic at 850 K.

(ii) Zinc oxide on heating becomes yellow.

(iii) Frenkel defect does not change the density of AgCl crystals. All India 2008C

49. With the help of suitable diagrams, on the basis of band theory, explain the difference between

(i) a conductor and an insulator.

(ii) a conductor and a semiconductor.

All India 2008C

PREVIOUS YEARS' EXAMINATION QUESTIONS

TOPIC 2

1 Mark Questions

1. Express the relationship between atomic radius (r) and the edge length (a) in the fcc unit cell. **Foreign 2014**
2. Express the relationship between atomic radius (r) and the edge length (a) in the bcc unit cell. **Foreign 2014**
3. Aluminium crystallises in fcc structure. Atomic radius of the metal is 125 pm. What is length of the side of the unit cell of the metal? **All India 2013**
4. What is the percentage efficiency of packing in case of a simple cubic lattice? **All India 2009C**

2 Marks Questions

5. An element with density 2.8 g cm^{-3} forms a fcc unit cell with edge length 4×10^{-8} cm. Calculate the molar mass of the element. (Given, $N_A = 6.022 \times 10^{23}$ mol^{-1}). **Delhi 2014**
6. The density of copper is 8.95 g cm^{-3}. It has a face centred cubic structure. What is the radius of copper atom? (Atomic mass of Cu = 63.5 g mol^{-1}, $N_A = 6.02 \times 10^{23}$ mol^{-1}). **Delhi 2014C**
7. An element with density 11.2 g cm^{-3} forms a fcc lattice with edge length of 4×10^{-8} cm. Calculate the atomic mass of the element. (Given, $N_A = 6.022 \times 10^{23}$ mol^{-1}). **All India 2014**
8. Iron has a body centred cubic unit cell with a cell dimension of 286.65 pm. The density of iron is 7.874 g cm^{-3}, use this information to calculate Avogadro's number. (Gram atomic mass of Fe = 55.84 g mol^{-1}). **Foreign 2014**

Or Iron has a body centred cubic unit cell with a cell edge of 286.65 pm. The density of iron is 7.874 g cm^{-3}. Use this information to calculate Avogadro's number. (Atomic mass of iron = 56 g mol^{-1}). All India 2012, 2009; Delhi 2012, 2009; Foreign 2010, 2009

9. Explain how can you determine the atomic mass of an unknown metal if you know its mass, density and the dimensions and type of unit cell of its crystal? All India 2011

10. Calculate the packing efficiency of a metal crystal for a simple cubic lattice. All India 2011; Delhi 2011C

11. Silver crystallises in face centred cubic unit cell. Each side of the unit cell has a length of 409 pm. What is the radius of silver atom? Foreign 2011, 2009; All India 2010, 2009

12. Copper crystallises into fcc lattice with edge length 3.61×10^{-8} cm. Calculate the density of copper. (Atomic mass of Cu = 63.5 g mol^{-1}, $N_A = 6.022 \times 10^{23}$ mol^{-1}). Delhi 2010C, 2009C

13. Chromium metal crystallises in a body centred cubic lattice. The length of the unit cell edge is found to be 287 pm. Calculate the atomic radius of chromium. Delhi 2010C

14. The edge of the face centred cubic unit cell of aluminium is 404 pm. Calculate the radius of aluminium atom. Delhi 2010C

3 Marks Questions

15. An element crystallises in a bcc lattice with cell edge of 500 pm. The density of the element is 7.5 g cm^{-3}. How many atoms are present in 300 g of the element? All India 2016

16. An element crystallises in a fcc lattice with cell edge of 250 pm. Calculate the density if 300 g of this element contain 2×10^{24} atoms. Delhi 2016

17. An element with molar mass 27 g mol^{-1} forms a cubic unit cell with edge length 4.05×10^{-8} cm. If its density is 2.7 g cm^{-3}, what is the nature of the cubic unit cell? Delhi 2015

18. An element X (molar mass = 60 g mol^{-1}) has a density of 6.23 g cm^{-3}. Identify the type of cubic unit cell, if the edge length of the unit cell is 4×10^{-8} cm. Foreign 2015

19. Silver crystallises in fcc lattice. If edge length of the unit cell is 4.077×10^{-8} cm, then calculate the radius of silver atom. All India 2015C

20. Niobium crystallises in body centered cubic structure. If its density is 8.55 g cm^{-3}, calculate the atomic radius of niobium, given its atomic mass is 93u. Delhi 2013C

21. An element occurs in bcc structure. It has a cell edge length of 250 pm. Calculate the molar mass if its density is 8.0 g cm^{-3}. Also, calculate the radius of an atom of this element. Delhi 2013C

22. Silver crystallises in face centred cubic (fcc) unit cell. If the radius of silver atom is 145 pm, what is the length of each side of the unit cell? Foreign 2012

23. Tungsten crystallises in body centred cubic unit cell. If the edge of the unit cell is 316.5 pm, what is the radius of tungsten atom? Delhi 2012

24. Copper crystallises with face centred cubic unit cell. If the radius of copper atom is 127.8 pm, calculate the density of copper metal. (Atomic mass of Cu = 63.55 u, $N_A = 6.02 \times 10^{23}$ mol^{-1}). All India 2012

25. An element X crystallises in fcc structure. 208 g of it has 4.2832×10^{24} atoms. Calculate the edge of unit cell if density of X is 7.2 g cm^{-3}. Delhi 2012C

26. The density of lead is 11.35 g cm^{-3} and the metal crystallises with fcc unit cell. Estimate the radius of lead atom (Atomic mass of lead = 207 g mol^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1}). **Delhi 2011**

27. Aluminium crystallises in a cubic close packed structure. Radius of the atom in the metal is 125 pm.

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

(ii) How many unit cells are there in 1 cm^3 of aluminium? **Foreign 2011**

28. Silver crystallises in face centred 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). **Delhi 2011**

29. The well known mineral fluoride 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 fcc lattice. The F^- ions fill all 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 g cm^{-3}. Use this information to calculate Avogadro's number. (Molar mass of CaF_2 = 78.08 g mol^{-1}). **Delhi 2010; Foreign 2010**

30. The density of copper metal is 8.95 g cm^{-3}. If the radius of copper atom is 127.8 pm, is the copper unit cell a simple cubic, a body centred cubic or face centred cubic structure? (Atomic mass of Cu = 63.54 g mol^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1}) **Delhi 2010; All India 2010**

31. Copper crystallises in face centred cubic lattice and has density of 8.930 g cm^{-3} at 293 K. Calculate the radius of copper atom. (Atomic mass of Cu = 63.55 u, $N_A = 6.02 \times 10^{23}$ mol^{-1}). **All India 2010C**

32. Silver crystallises in fcc lattice. If the edge length of the unit cell is 4.07×10^{-8} cm and the density of the crystal is 10.5 g cm^{-3}, calculate the atomic mass of silver. ($N_A = 6.02 \times 10^{23}$ atom mol^{-1}). **All India 2008, 2010; Foreign 2008**

5 Marks Question

33. (i) An element has atomic mass 93 g mol^{-1} and density 11.5 g cm^{-3}. If the edge length of its unit cell is 300 pm, identify the type of unit cell.

(ii) Write any two differences between amorphous solids and crystalline solids. **Delhi 2017**

Explanations

1. For face centred cubic unit cell,

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

where, r = radius, a = edge length

2. For body centred cubic unit cell,

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

where, r = radius

a = edge length

3. Calculate by using formula, $a = \frac{4r}{\sqrt{2}}$

Given, $r = 125$ pm, $a = ?$

For fcc, $a = \frac{4}{\sqrt{2}}r = \frac{4 \times 125}{\sqrt{2}} = \frac{500}{1.414} = 353.61$ pm

4. Packing efficiency in a simple cubic lattice = 52.4%.

5. Given that, density, $d = 2.8$ g cm^{-3}

Edge length, $a = 4 \times 10^{-8}$ cm

For fcc, $Z = 4$

Applying the formula, $d = \frac{ZM}{a^3 N_A}$

$$\therefore \quad M = \frac{da^3 N_A}{Z} = \frac{2.8 \times (4 \times 10^{-8})^3 \times 6.022 \times 10^{23}}{4}$$

$$M = 26.98 = 27 \text{ g mol}^{-1}$$

2 Marks Questions

20. Calculate the number of unit cells in 8.1 g of aluminium, if it crystallises in a face centred cubic (fcc) structure.
(Atomic mass of Al = 27 g mol^{-1}) **All India 2017**

21. How will you distinguish between the following pairs of terms?
(i) Tetrahedral and octahedral voids
(ii) Crystal lattice and unit cell
Delhi 2014

22. A compound forms hcp structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids?
All India 2013C

23. Define the following terms in relation to crystalline solids.
(i) Unit cell
(ii) Coordination number
Give one example in each case. **All India 2011**

24. An alloy of gold and cadmium crystallises with a cubic structure in which gold atoms occupy the corners and cadmium atoms fit into the face centres. Assign formula for this alloy. **All India 2011C**

25. (i) In reference to crystal structure, explain the meaning of the coordination number.
(ii) What is the number of atoms in a unit cell of
(a) a face centred cubic structure?
(b) a body centred cubic structure?
Delhi 2009C