Unit

1

SOLID STATE

I. Multiple Choice Questions (Type-I)

1. Which of the following conditions favours the existence of a substance in the solid state?

(i) High temperature

(ii) Low temperature

(iii) High thermal energy

(iv) Weak cohesive forces

2. Which of the following is **not** a characteristic of a crystalline solid?

(i) Definite and characteristic heat of fusion.

(ii) Isotropic nature.

(iii) A regular periodically repeated pattern of arrangement of constituent particles in the entire crystal.

(iv) A true solid

3. Which of the following is an amorphous solid?

(i) Graphite (C)

(ii) Quartz glass (SiO_2)

(iii) Chrome alum

(iv) Silicon carbide (SiC)

4. Which of the following arrangements shows schematic alignment of magnetic moments of antiferromagnetic substances?

(i) 

(ii) 

(iii) 

(iv) 

5. Which of the following is true about the value of refractive index of quartz glass?

(i) Same in all directions

(ii) Different in different directions

(iii) Cannot be measured

(iv) Always zero

6. Which of the following statement is **not** true about amorphous solids?

(i) On heating they may become crystalline at certain temperature.

(ii) They may become crystalline on keeping for long time.

(iii) Amorphous solids can be moulded by heating.

(iv) They are anisotropic in nature.

7. The sharp melting point of crystalline solids is due to _____.

(i) a regular arrangement of constituent particles observed over a short distance in the crystal lattice.

(ii) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.

(iii) same arrangement of constituent particles in different directions.

(iv) different arrangement of constituent particles in different directions.

8. Iodine molecules are held in the crystals lattice by _____.

(i) london forces

(ii) dipole-dipole interactions

(iii) covalent bonds

(iv) coulombic forces

9. Which of the following is a network solid?

(i) SO_2 (Solid)

(ii) I_2

(iii) Diamond

(iv) H_2O (Ice)

10. Which of the following solids is **not** an electrical conductor?

(A) Mg (s) (B) TiO (s) (C) I_2 (s) (D) H_2O (s)

(i) (A) only

(ii) (B) Only

(iii) (C) and (D)

(iv) (B), (C) and (D)

11. Which of the following is **not** the characteristic of ionic solids?

(i) Very low value of electrical conductivity in the molten state.

(ii) Brittle nature.

(iii) Very strong forces of interactions.

(iv) Anisotropic nature.

12. Graphite is a good conductor of electricity due to the presence of _____.

(i) lone pair of electrons

(ii) free valence electrons

(iii) cations

(iv) anions

13. Which of the following oxides behaves as conductor or insulator depending upon temperature?

(i) TiO

(ii) SiO_2

(iii) TiO_3

(iv) MgO

14. Which of the following oxides shows electrical properties like metals?

(i) SiO_2

(ii) MgO

(iii) $SO_2(s)$

(iv) CrO_2

15. The lattice site in a pure crystal **cannot** be occupied by _____.

(i) molecule

(ii) ion

(iii) electron

(iv) atom

16. Graphite **cannot** be classified as _____.

(i) conducting solid

(ii) network solid

(iii) covalent solid

(iv) ionic solid

17. Cations are present in the interstitial sites in _____.

(i) Frenkel defect

(ii) Schottky defect

(iii) Vacancy defect

(iv) Metal deficiency defect

18. Schottky defect is observed in crystals when _____.

(i) some cations move from their lattice site to interstitial sites.

(ii) equal number of cations and anions are missing from the lattice.

(iii) some lattice sites are occupied by electrons.

(iv) some impurity is present in the lattice.

19. Which of the following is true about the charge acquired by *p*-type semiconductors?

(i) positive

(ii) neutral

(iii) negative

(iv) depends on concentration of *p* impurity

20. To get *a n*-type semiconductor from silicon, it should be doped with a substance with valence_____.

(i) 2

(ii) 1

(iii) 3

(iv) 5

21. The total number of tetrahedral voids in the face centred unit cell is _____.

(i) 6

(ii) 8

(iii) 10

(iv) 12

22. Which of the following point defects are shown by AgBr(s) crystals?

(A) Schottky defect (B) Frenkel defect

(C) Metal excess defect (D) Metal deficiency defect

(i) (A) and (B)

(ii) (C) and (D)

(iii) (A) and (C)

(iv) (B) and (D)

23. In which pair most efficient packing is present?

(i) *hcp* and *bcc*

(ii) *hcp* and *ccp*

(iii) *bcc* and *ccp*

(iv) *bcc* and simple cubic cell

24. The percentage of empty space in a body centred cubic arrangement is _____.

(i) 74

(ii) 68

(iii) 32

(iv) 26

25. Which of the following statement is **not** true about the hexagonal close packing?

(i) The coordination number is 12.

(ii) It has 74% packing efficiency.

(iii) Tetrahedral voids of the second layer are covered by the spheres of the third layer.

(iv) In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer.

26. In which of the following structures coordination number for cations and anions in the packed structure will be same?

(i) Cl^- ion form *fcc* lattice and Na^+ ions occupy all octahedral voids of the unit cell.

(ii) Ca^{2+} ions form *fcc* lattice and F^- ions occupy all the eight tetrahedral voids of the unit cell.

(iii) O^{2-} ions form *fcc* lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell.

(iv) S^{2-} ions form *fcc* lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

27. What is the coordination number in a square close packed structure in two dimensions?

(i) 2

(ii) 3

(iii) 4

(iv) 6

28. Which kind of defects are introduced by doping?

(i) Dislocation defect

(ii) Schottky defect

(iii) Frenkel defects

(iv) Electronic defects

29. Silicon doped with electron-rich impurity forms _____.

(i) *p*-type semiconductor

(ii) *n*-type semiconductor

(iii) intrinsic semiconductor

(iv) insulator

30. Which of the following statements is **not** true?

(i) Paramagnetic substances are weakly attracted by magnetic field.

(ii) Ferromagnetic substances cannot be magnetised permanently.

(iii) The domains in antiferromagnetic substances are oppositely oriented with respect to each other.

(iv) Pairing of electrons cancels their magnetic moment in the diamagnetic substances.

31. Which of the following is **not** true about the ionic solids?

(i) Bigger ions form the close packed structure.

(ii) Smaller ions occupy either the tetrahedral or the octahedral voids depending upon their size.

(iii) Occupation of all the voids is not necessary.

(iv) The fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions occupying the voids.

32. A ferromagnetic substance becomes a permanent magnet when it is placed in a magnetic field becuase _____.

(i) all the domains get oriented in the direction of magnetic field.

(ii) all the domains get oriented in the direction opposite to the direction of magnetic field.

(iii) domains get oriented randomly.

(iv) domains are not affected by magnetic field.

33. The correct order of the packing efficiency in different types of unit cells is _____.

(i) *fcc* < *bcc* < simple cubic

(ii) *fcc* > *bcc* > simple cubic

(iii) *fcc* < *bcc* > simple cubic

(iv) *bcc* < *fcc* > simple cubic

34. Which of the following defects is also known as dislocation defect?

(i) Frenkel defect

(ii) Schottky defect

(iii) Non-stoichiometric defect

(iv) Simple interstitial defect

35. In the cubic close packing, the unit cell has _____.

(i) 4 tetrahedral voids each of which is shared by four adjacent unit cells.

(ii) 4 tetrahedral voids within the unit cell.

(iii) 8 tetrahedral voids each of the which is shared by four adjacent unit cells.

(iv) 8 tetrahedral voids within the unit cells.

36. The edge lengths of the unit cells in terms of the radius of spheres constituting *fcc*, *bcc* and simple cubic unit cell are respectively_____.

(i) $2\sqrt{2}r, \frac{4r}{\sqrt{3}}, 2r$

(ii) $\frac{4r}{\sqrt{3}}, 2\sqrt{2}r, 2r$

(iii) $2r, 2\sqrt{2}r, \frac{4r}{\sqrt{3}}$

(iv) $2r, \frac{4r}{\sqrt{3}}, 2\sqrt{2}r$

37. Which of the following represents correct order of conductivity in solids?

(i) $\kappa_{\text{metals}} >> \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

(ii) $\kappa_{\text{metals}} << \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

(iii) $\kappa_{\text{metals}} \simeq \kappa_{\text{semiconductors}} > \kappa_{\text{insulators}} = \text{zero}$

(iv) $\kappa_{\text{metals}} < \kappa_{\text{semiconductors}} > \kappa_{\text{insulators}} \neq \text{zero}$

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

38. Which of the following is **not** true about the voids formed in 3 dimensional hexagonal close packed structure?

(i) A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer.

(ii) All the triangular voids are not covered by the spheres of the second layer.

(iii) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap.

(iv) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

39. The value of magnetic moment is zero in the case of antiferromagnetic substances because the domains _____.

(i) get oriented in the direction of the applied magnetic field.

(ii) get oriented opposite to the direction of the applied magnetic field.

(iii) are oppositely oriented with respect to each other without the application of magnetic field.

(iv) cancel out each other's magnetic moment.

40. Which of the following statements are **not** true?

(i) Vacancy defect results in a decrease in the density of the substance.

(ii) Interstitial defects results in an increase in the density of the substance.

(iii) Impurity defect has no effect on the density of the substance.

(iv) Frankel defect results in an increase in the density of the substance.

41. Which of the following statements are true about metals?

(i) Valence band overlaps with conduction band.

(ii) The gap between valence band and conduction band is negligible.

(iii) The gap between valence band and conduction band cannot be determined.

(iv) Valence band may remain partially filled.

42. Under the influence of electric field, which of the following statements is true about the movement of electrons and holes in a *p*-type semi conductor?

(i) Electron will move towards the positvely charged plate through electron holes.

(ii) Holes will appear to be moving towards the negatively charged plate.

(iii) Both electrons and holes appear to move towards the positively charged plate.

(iv) Movement of electrons is not related to the movement of holes.

43. Which of the following statements are true about semiconductors?

(i) Silicon doped with electron rich impurity is a *p*-type semiconductor.

(ii) Silicon doped with an electron rich impurity is an *n*-type semiconductor.

(iii) Delocalised electrons increase the conductivity of doped silicon.

(iv) An electron vacancy increases the conductivity of *n*-type semiconductor.

44. An excess of potassium ions makes KCl crystals appear violet or lilac in colour since _____.

(i) some of the anionic sites are occupied by an unpaired electron.

(ii) some of the anionic sites are occupied by a pair of electrons.

(iii) there are vacancies at some anionic sites.

(iv) F-centres are created which impart colour to the crystals.

45. The number of tetrahedral voids per unit cell in NaCl crystal is _____.

(i) 4

(ii) 8

(iii) twice the number of octahedral voids.

(iv) four times the number of octahedral voids.

46. Amorphous solid can also be called _____.

(i) pseudo solids

(ii) true solids

(iii) super cooled liquids

(iv) super cooled solids

47. A perfect crystal of silicon (Fig. 1.1) is doped with some elements as given in the options. Which of these options show *n*-type semiconductors?

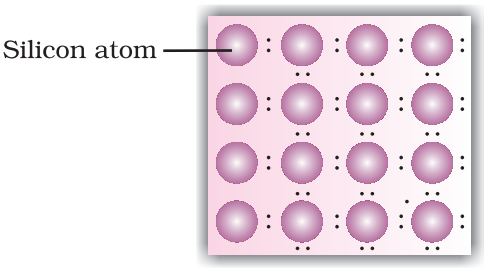
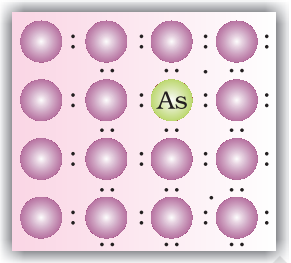
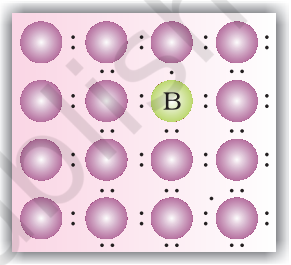


Fig. 1.1 Pure crystal

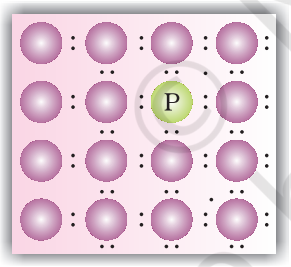
(i)



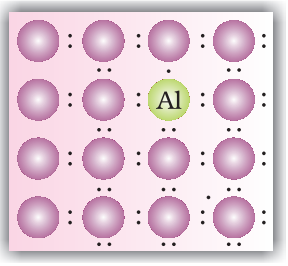
(ii)



(iii)



(iv)



48. Which of the following statements are correct?

(i) Ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic.

(ii) Ferrimagnetic substances do not lose ferrimagnetism on heating and remain ferrimagnetic.

(iii) Antiferromagnetic substances have domain structures similar to ferromagnetic substances and their magnetic moments are not cancelled by each other.

(iv) In ferromagnetic substances all the domains get oriented in the direction of magnetic field and remain as such even after removing magnetic field.

49. Which of the following features are **not** shown by quartz glass?

(i) This is a crystalline solid.

(ii) Refractive index is same in all the directions.

(iii) This has definite heat of fusion.

(iv) This is also called super cooled liquid.

50. Which of the following **cannot** be regarded as molecular solid?

(i) SiC (Silicon carbide)

(ii) AlN

(iii) Diamond

(iv) I_2

51. In which of the following arrangements octahedral voids are formed?

(i) *hcp*

(ii) *bcc*

(iii) simple cubic

(iv) *fcc*

52. Frenkel defect is also known as _____.

(i) stoichiometric defect

(ii) dislocation defect

(iii) impurity defect

(iv) non-stoichometric defect

53. Which of the following defects decrease the density?

(i) Interstitial defect

(ii) Vacancy defect

(iii) Frankel defect

(iv) Schottky defect

III. Short Answer Type

54. Why are liquids and gases categorised as fluids?

55. Why are solids incompressible?

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

57. Why does table salt, NaCl, some times appear yellow in colour?

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

59. Why does white ZnO (s) becomes yellow upon heating?

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

61. Explain why does conductivity of germanium crystals increase on doping with galium.

62. 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?

63. Under which situations can an amorphous substance change to crystalline form?

IV. Matching Type

Note : In the following questions match the items given in Column I with the items given in Column II. In some questions more than one item of Column I and Column II may match.

64. Match the defects given in Column I with the statements in given Column II.

Column I	**Column II**
(i) Simple vacancy defect	(a) shown by non-ionic solids and increases density of the solid.
(ii) Simple interstitial defect	(b) shown by ionic solids and decreases density of the solid.
(iii) Frenkel defect	(c) shown by non ionic solids and density of the solid decreases
(iv) Schottky defect	(d) shown by ionic solids and density of the solid remains the same.

65. Match the type of unit cell given in Column I with the features given in Column II.

Column I	**Column II**
(i) Primitive cubic unit cell	(a) Each of the three perpendicular edges compulsorily have the different edge length i.e; $a \neq b \neq c$.
(ii) Body centred cubic unit cell	(b) Number of atoms per unit cell is one.
(iii) Face centred cubic unit cell	(c) Each of the three perpendicular edges compulsorily have the same edge length i.e; $a = b = c$
(iv) End centred orthorhombic unit cell	(d) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is one.
	(e) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is three.

66. Match the types of defect given in Column I with the statement given in Column II.

	Column I		**Column II**
(i)	Impurity defect	(a)	NaCl with anionic sites called F-centres
(ii)	Metal excess defect	(b)	FeO with Fe^{3+}
(iii)	Metal deficiency defect	(c)	NaCl with Sr^{2+} and some cationic sites vacant

67. Match the items given in Column I with the items given in Column II.

	Column I		**Column II**
(i)	Mg in solid state	(a)	*p*-Type semiconductor
(ii)	$MgCl_2$ in molten state	(b)	*n*-Type semiconductor
(iii)	Silicon with phosphorus	(c)	Electrolytic conductors
(iv)	Germanium with boron	(d)	Electronic conductors

68. Match the type of packing given in Column I with the items given in Column II.

	Column I		**Column II**
(i)	Square close packing in two dimensions	(a)	Triangular voids
(ii)	Hexagonal close packing in two dimensions	(b)	Pattern of spheres is repeated in every fourth layer
(iii)	Hexagonal close packing in three dimensions	(c)	Coordination number 4
(iv)	Cubic close packing in three dimensions	(d)	Pattern of sphere is repeated in alternate layers

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Assertion is wrong statement but reason is correct statement.

69. **Assertion** : The total number of atoms present in a simple cubic unit cell is one.
Reason : Simple cubic unit cell has atoms at its corners, each of which is shared between eight adjacent unit cells.

70. **Assertion** : Graphite is a good conductor of electricity however diamond belongs to the category of insulators.
Reason : Graphite is soft in nature on the other hand diamond is very hard and brittle.

71. **Assertion** : Total number of octahedral voids present in unit cell of cubic close packing including the one that is present at the body centre, is four.
Reason : Besides the body centre there is one octahedral void present at the centre of each of the six faces of the unit cell and each of which is shared between two adjacent unit cells.

72. **Assertion** : The packing efficiency is maximum for the *fcc* structure.
Reason : The cordination number is 12 in *fcc* structures.

73. **Assertion** : Semiconductors are solids with conductivities in the intermediate range from $10^{-6} - 10^{4}$ $ohm^{-1}m^{-1}$.
Reason : Intermediate conductivity in semiconductor is due to partially filled valence band.

VI. Long Answer Type

74. With the help of a labelled diagram show that there are four octahedral voids per unit cell in a cubic close packed structure.

75. Show that in a cubic close packed structure, eight tetrahedral voids are present per unit cell.

76. How does the doping increase the conductivity of semiconductors?

77. A sample of ferrous oxide has actual formula $Fe_{0.93}O_{1.00}$. In this sample what fraction of metal ions are Fe^{2+} ions? What type of nonstoichiometric defect is present in this sample?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii)	2. (ii)	3. (ii)	4. (iv)	5. (i)	6. (iv)
7. (ii)	8. (i)	9. (iii)	10. (iii)	11. (i)	12. (ii)
13. (iii)	14. (iv)	15. (iii)	16. (iv)	17. (i)	18. (ii)
19. (ii)	20. (iv)	21. (ii)	22. (i)	23. (ii)	24. (iii)
25. (iv)	26. (i)	27. (iii)	28. (iv)	29. (ii)	30. (ii)
31. (iv)	32. (i)	33. (ii)	34. (i)	35. (iv)	36. (i)
37. (i)					

II. Multiple Choice Questions (Type-II)

38. (iii), (iv)	39. (iii), (iv)	40. (iii), (iv)	41. (i), (ii), (iv)
42. (i), (ii)	43. (ii), (iii)	44. (i), (iv)	45. (ii), (iii)
46. (i), (iii)	47. (i), (iii)	48. (i), (iv)	49. (i), (iii)
50. (i), (ii), (iii)	51. (i), (iv)	52. (i), (ii)	53. (ii), (iv)

III. Short Answer Type

54. The liquids and gases have a property to flow i.e. the molecules can move past and tumble over one another freely. Hence, they have been categorised as fluids.

55. The distance between the constituent particles (atoms, ions, molecules etc.) is very less in solids. On bringing them still closer repulsion will start between electron clouds of these particles. Hence, they cannot be brought further close to each other.

56. Crystals have long range repeated pattern of arrangement of constitutent particles but in the process of crystallisation some deviations from the ideal arrangement (i.e. defects) may be introduced, therefore, crystals are usually not perfect.

57. Yellow colour in sodium chloride is due to metal excess defect due to which unpaired electrons occupy anionic sites. These sites are called F-centres. These electrons absorb energy from the visible region for the excitation which makes crystal appear yellow.

58. In the crystals of FeO, some of the Fe^{2+} cations are replaced by Fe^{3+} ions. Three Fe^{2+} ions are replaced by two Fe^{3+} ions to make up for the loss of positive charge. Eventually there would be less amount of metal as compared to stoichiometric proportion.

59. On heating ZnO loses oxygen according to the following reaction.

$$ZnO \xrightarrow{\text{heating}} Zn^{2+} + \frac{1}{2}O_2 + 2e^-$$

Zn^{2+} ions and electrons move to interstitial sites and F-centres are created which impart yellow colour to ZnO(s).

60. The gap between conduction band and valence band is small in semiconductors (Fig. 1.1), therefore, electrons from the valence band can jump to the conduction band on increasing temperature. Thus they become more conducting as the temperature increases.

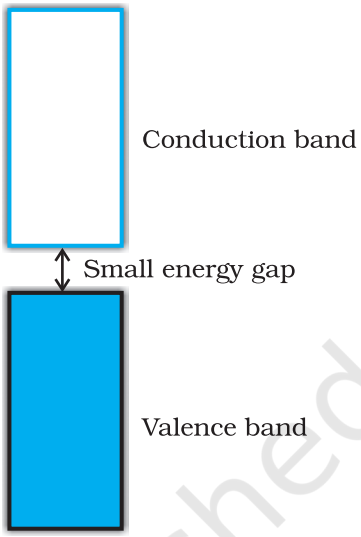


Fig. 1.2 : Semi conductor

61. On doping germanium with galium some of the positions of lattice of germanium are occupied by galium. Galium atom has only three valence electrons. Therefore, fourth valency of nearby germanium atom is not satisfied. The place remains vacant. This place is deficient of electrons and is therefore called electron hole or electron vacancy. Electron from neighbouring atom comes and fills the gap, thereby creating a hole in its original position. Under the influence of electric field electrons move towards positively charged plates through these holes and conduct electricity. The holes appear to move towards negatively charged plates.

62. M_2N_3

63. See page no. 3 of NCERT textbook for Class XII.

IV. Matching Type

64.	(i) → (c)	(ii) → (a)	(iii) → (d)	(iv) → (b)
65.	(i) → (b), (c)	(ii) → (c), (d)	(iii) → (c), (e)	(iv) → (a), (d)
66.	(i) → (c)	(ii) → (a)	(iii) → (b)	
67.	(i) → (d)	(ii) → (c)	(iii) → (b)	(iv) → (a)
68.	(i) → (c)	(ii) → (a)	(iii) → (d)	(iv) → (b)

V. Assertion and Reason Type

69. (i) 70. (ii) 71. (iii) 72. (ii) 73. (iii)

VI. Long Answer Type

74. [**Hint :** Draw structure and discuss]

75. [**Hint :**Draw structure and discuss]

76. See page no. 26 of NCERT textbook for Class XII.

77. Let the formula of sample be

$(Fe^{2+})_x (Fe^{3+})_y O$.

On looking at the given formula of the compound

$x + y = 0.93$ ... (1)

Total positive charge on ferrous and ferric ions should balance the two units of negative charge on oxygen. Therefore,

$2x + 3y = 2$ ... (2)

$\Rightarrow \quad x + \frac{3}{2}y = 1$ ... (3)

On subtracting equation (1) from equation (3) we have

$$\frac{3}{2}y - y = 1 - 0.93$$

$$\Rightarrow \quad \frac{1}{2}y = 0.07$$

$$\Rightarrow \quad y = 0.14$$

On putting the value of y in equation (1) we get,

$x + 0.14 = 0.93$

$\Rightarrow \quad x = 0.93 - 0.14$

$x = 0.79$

Fraction of Fe^{2+} ions present in the sample = $\frac{0.79}{0.93} = 0.81$

Metal deficiency defect is present in the sample because iron is less in amount than that required for stoichiometric composition.

Unit

2

SOLUTIONS

I. Multiple Choice Questions (Type-I)

1. Which of the following units is useful in relating concentration of solution with its vapour pressure?

(i) mole fraction

(ii) parts per million

(iii) mass percentage

(iv) molality

2. On dissolving sugar in water at room temperature solution feels cool to touch. Under which of the following cases dissolution of sugar will be most rapid?

(i) Sugar crystals in cold water.

(ii) Sugar crystals in hot water.

(iii) Powdered sugar in cold water.

(iv) Powdered sugar in hot water.

3. At equilibrium the rate of dissolution of a solid solute in a volatile liquid solvent is _____.

(i) less than the rate of crystallisation

(ii) greater than the rate of crystallisation

(iii) equal to the rate of crystallisation

(iv) zero

4. A beaker contains a solution of substance 'A'. Precipitation of substance 'A' takes place when small amount of 'A' is added to the solution. The solution is _____.

(i) saturated

(ii) supersaturated

(iii) unsaturated

(iv) concentrated

5. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does **not** depend upon _____.

(i) Temperature

(ii) Nature of solute

(iii) Pressure

(iv) Nature of solvent

6. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to _____.

(i) low temperature

(ii) low atmospheric pressure

(iii) high atmospheric pressure

(iv) both low temperature and high atmospheric pressure

7. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult's law?

(i) Methanol and acetone.

(ii) Chloroform and acetone.

(iii) Nitric acid and water.

(iv) Phenol and aniline.

8. Colligative properties depend on _____.

(i) the nature of the solute particles dissolved in solution.

(ii) the number of solute particles in solution.

(iii) the physical properties of the solute particles dissolved in solution.

(iv) the nature of solvent particles.

9. Which of the following aqueous solutions should have the highest boiling point?

(i) 1.0 M NaOH

(ii) 1.0 M Na_2SO_4

(iii) 1.0 M NH_4NO_3

(iv) 1.0 M KNO_3

10. The unit of ebulioscopic constant is _____.

(i) K kg mol^{-1} or K (molality)$^{-1}$

(ii) mol kg K^{-1} or K^{-1}(molality)

(iii) kg mol^{-1} K^{-1} or $K^{-1}(molality)^{-1}$

(iv) K mol kg^{-1} or K (molality)

11. In comparison to a 0.01 M solution of glucose, the depression in freezing point of a 0.01 M $MgCl_2$ solution is _____.

(i) the same

(ii) about twice

(iii) about three times

(iv) about six times

12. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _____.

(i) it gains water due to osmosis.

(ii) it loses water due to reverse osmosis.

(iii) it gains water due to reverse osmosis.

(iv) it loses water due to osmosis.

13. At a given temperature, osmotic pressure of a concentrated solution of a substance _____.

(i) is higher than that at a dilute solution.

(ii) is lower than that of a dilute solution.

(iii) is same as that of a dilute solution.

(iv) cannot be compared with osmotic pressure of dilute solution.

14. Which of the following statements is false?

(i) Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.

(ii) The osmotic pressure of a solution is given by the equation $\Pi = CRT$ (where C is the molarity of the solution).

(iii) Decreasing order of osmotic pressure for 0.01 M aqueous solutions of barium chloride, potassium chloride, acetic acid and sucrose is

$BaCl_2 > KCl > CH_3COOH >$ sucrose.

(iv) According to Raoult's law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.

15. The values of Van't Hoff factors for KCl, NaCl and K_2SO_4, respectively, are _____.

(i) 2, 2 and 2

(ii) 2, 2 and 3

(iii) 1, 1 and 2

(iv) 1, 1 and 1

16. Which of the following statements is **false**?

(i) Units of atmospheric pressure and osmotic pressure are the same.

(ii) In reverse osmosis, solvent molecules move through a semipermeable membrane from a region of lower concentration of solute to a region of higher concentration.

(iii) The value of molal depression constant depends on nature of solvent.

(iv) Relative lowering of vapour pressure, is a dimensionless quantity.

17. Value of Henry's constant K_H _____.

(i) increases with increase in temperature.

(ii) decreases with increase in temperature.

(iii) remains constant.

(iv) first increases then decreases.

18. The value of Henry's constant K_H is _____.

(i) greater for gases with higher solubility.

(ii) greater for gases with lower solubility.

(iii) constant for all gases.

(iv) not related to the solubility of gases.

19. Consider the Fig. 2.1 and mark the correct option.

(i) water will move from side (A) to side (B) if a pressure lower than osmotic pressure is applied on piston (B).

(ii) water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).

(iii) water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).

(iv) water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

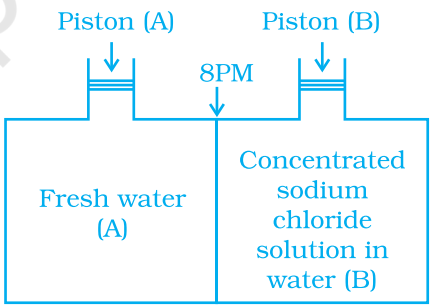


Fig. *2.1*

20. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in the order_____.

(i) $i_A < i_B < i_C$

(ii) $i_A > i_B > i_C$

(iii) $i_A = i_B = i_C$

(iv) $i_A < i_B > i_C$

21. On the basis of information given below mark the correct option.

Information:

(A) In bromoethane and chloroethane mixture intermolecular interactions of A–A and B–B type are nearly same as A–B type interactions.

(B) In ethanol and acetone mixture A–A or B–B type intermolecular interactions are stronger than A–B type interactions.

(C) In chloroform and acetone mixture A–A or B–B type intermolecular interactions are weaker than A–B type interactions.

(i) Solution (B) and (C) will follow Raoult's law.

(ii) Solution (A) will follow Raoult's law.

(iii) Solution (B) will show negative deviation from Raoult's law.

(iv) Solution (C) will show positive deviation from Raoult's law.

22. Two beakers of capacity 500 mL were taken. One of these beakers, labelled as "A", was filled with 400 mL water whereas the beaker labelled "B" was filled with 400 mL of 2 M solution of NaCl. At the same temperature both the beakers were placed in closed containers of same material and same capacity as shown in Fig. 2.2.

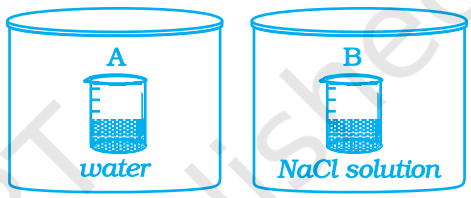


Fig. *2.2*

At a given temperature, which of the following statement is correct about the vapour pressure of pure water and that of NaCl solution.

(i) vapour pressure in container (A) is more than that in container (B).

(ii) vapour pressure in container (A) is less than that in container (B).

(iii) vapour pressure is equal in both the containers.

(iv) vapour pressure in container (B) is twice the vapour pressure in container (A).

23. If two liquids A and B form minimum boiling azeotrope at some specific composition then _____.

(i) A–B interactions are stronger than those between A–A or B–B.

(ii) vapour pressure of solution increases because more number of molecules of liquids A and B can escape from the solution.

(iii) vapour pressure of solution decreases because less number of molecules of only one of the liquids escape from the solution.

(iv) A–B interactions are weaker than those between A–A or B–B.

24. 4L of 0.02 M aqueous solution of NaCl was diluted by adding one litre of water. The molality of the resultant solution is _____.

(i) 0.004

(ii) 0.008

(iii) 0.012

(iv) 0.016

25. On the basis of information given below mark the correct option.

Information : On adding acetone to methanol some of the hydrogen bonds between methanol molecules break.

(i) At specific composition methanol-acetone mixture will form minimum boiling azeotrope and will show positive deviation from Raoult's law.

(ii) At specific composition methanol-acetone mixture forms maximum boiling azeotrope and will show positive deviation from Raoult's law.

(iii) At specific composition methanol-acetone mixture will form minimum boiling azeotrope and will show negative deviation from Raoult's law.

(iv) At specific composition methanol-acetone mixture will form maximum boiling azeotrope and will show negative deviation from Raoult's law.

26. K_H value for Ar(g), CO_2(g), HCHO (g) and CH_4(g) are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively.

Arrange these gases in the order of their increasing solubility.

(i) $HCHO < CH_4 < CO_2 < Ar$

(ii) $HCHO < CO_2 < CH_4 < Ar$

(iii) $Ar < CO_2 < CH_4 < HCHO$

(iv) $Ar < CH_4 < CO_2 < HCHO$

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

27. Which of the following factor (s) affect the solubility of a gaseous solute in the fixed volume of liquid solvent?

(a) nature of solute (b) temperature (c) pressure

(i) (a) and (c) at constant T

(ii) (a) and (b) at constant P

(iii) (b) and (c) only

(iv) (c) only

28. Intermolecular forces between two benzene molecules are nearly of same strength as those between two toluene molecules. For a mixture of benzene and toluene, which of the following are **not** true?

(i) $\Delta_{mix}H$ = zero

(ii) $\Delta_{mix}V$ = zero

(iii) These will form minimum boiling azeotrope.

(iv) These will not form ideal solution.

29. Relative lowering of vapour pressure is a colligative property because _____.

(i) It depends on the concentration of a non electrolyte solute in solution and does not depend on the nature of the solute molecules.

(ii) It depends on number of particles of electrolyte solute in solution and does not depend on the nature of the solute particles.

(iii) It depends on the concentration of a non electrolyte solute in solution as well as on the nature of the solute molecules.

(iv) It depends on the concentration of an electrolyte or nonelectrolyte solute in solution as well as on the nature of solute molecules.

30. Van't Hoff factor i is given by the expression _____.

(i) $i = \dfrac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$

(ii) $i = \dfrac{\text{Abnormal molar mass}}{\text{Normal molar mass}}$

(iii) $i = \dfrac{\text{Observed colligative property}}{\text{Calculated colligative property}}$

(iv) $i = \dfrac{\text{Calculated colligative property}}{\text{Observed colligative property}}$

31. Isotonic solutions must have the same _____.

(i) solute

(ii) density

(iii) elevation in boiling point

(iv) depression in freezing point

32. Which of the following binary mixtures will have same composition in liquid and vapour phase?

(i) Benzene - Toluene

(ii) Water-Nitric acid

(iii) Water-Ethanol

(iv) *n*-Hexane - *n*-Heptane

33. In isotonic solutions _____.

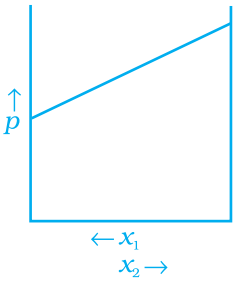
(i) solute and solvent both are same.

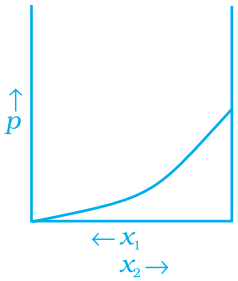
(ii) osmotic pressure is same.

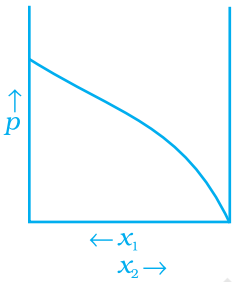
(iii) solute and solvent may or may not be same.

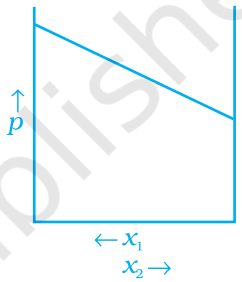
(iv) solute is always same solvent may be different.

34. For a binary ideal liquid solution, the variation in total vapour pressure versus composition of solution is given by which of the curves?

(i) 

(ii) 

(iii) 

(iv) 

35. Colligative properties are observed when _____.

(i) a non volatile solid is dissolved in a volatile liquid.

(ii) a non volatile liquid is dissolved in another volatile liquid.

(iii) a gas is dissolved in non volatile liquid.

(iv) a volatile liquid is dissolved in another volatile liquid.

III. Short Answer Type

36. Components of a binary mixture of two liquids A and B were being separated by distillation. After some time separation of components stopped and composition of vapour phase became same as that of liquid phase. Both the components started coming in the distillate. Explain why this happened.

37. Explain why on addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.

38. Explain the solubility rule "like dissolves like" in terms of intermolecular forces that exist in solutions.

39. Concentration terms such as mass percentage, ppm, mole fraction and molality are independent of temperature, however molarity is a function of temperature. Explain.

40. What is the significance of Henry's Law constant K_H?

41. Why are aquatic species more comfortable in cold water in comparison to warm water?

42. (a) Explain the following phenomena with the help of Henry's law.

(i) Painful condition known as bends.

(ii) Feeling of weakness and discomfort in breathing at high altitude.

(b) Why soda water bottle kept at room temperature fizzes on opening?

43. Why is the vapour pressure of an aqueous solution of glucose lower than that of water?

44. How does sprinkling of salt help in clearing the snow covered roads in hilly areas? Explain the phenomenon involved in the process.

45. What is "semi permeable membrane"?

46. Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis.

IV. Matching Type

Note : In the following questions match the items given in Column I and Column II.

47. Match the items given in Column I and Column II.

	Column I		**Column II**
(i)	Saturated solution	(a)	Solution having same osmotic pressure at a given temperature as that of given solution.
(ii)	Binary solution	(b)	A solution whose osmotic pressure is less than that of another.
(iii)	Isotonic solution	(c)	Solution with two components.
(iv)	Hypotonic solution	(d)	A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
(v)	Solid solution	(e)	A solution whose osmotic pressure is more than that of another.
(vi)	Hypertonic solution	(f)	A solution in solid phase.

48. Match the items given in Column I with the type of solutions given in Column II.

Column I		Column II	
(i)	Soda water	(a)	A solution of gas in solid
(ii)	Sugar solution	(b)	A solution of gas in gas
(iii)	German silver	(c)	A solution of solid in liquid
(iv)	Air	(d)	A solution of solid in solid
(v)	Hydrogen gas in palladium	(e)	A solution of gas in liquid
		(f)	A solution of liquid in solid

49. Match the laws given in Column I with expresions given in Column II.

Column I		Column II	
(i)	Raoult's law	(a)	$\Delta T_f = K_f m$
(ii)	Henry's law	(b)	$\Pi = CRT$
(iii)	Elevation of boiling point	(c)	$p = x_1 p_1^o + x_2 p_2^o$
(iv)	Depression in freezing point	(d)	$\Delta T_b = K_b m$
(v)	Osmotic pressure	(e)	$p = K_H . x$

50. Match the terms given in Column I with expressions given in Column II.

Column I		Column II	
(i)	Mass percentage	(a)	$\frac{\text{Number of moles of the solute component}}{\text{Volume of solution in litres}}$
(ii)	Volume percentage	(b)	$\frac{\text{Number of moles of a component}}{\text{Total number of moles of all the components}}$
(iii)	Mole fraction	(c)	$\frac{\text{Volume of the solute component in solution}}{\text{Total volume of solution}} \times 100$
(iv)	Molality	(d)	$\frac{\text{Mass of the solute component in solution}}{\text{Total mass of the solution}} \times 100$
(v)	Molarity	(e)	$\frac{\text{Number of moles of the solute components}}{\text{Mass of solvent in kilograms}}$

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Assertion and reason both are incorrect statements.
(v) Assertion is wrong statement but reason is correct statement.

51. **Assertion** : Molarity of a solution in liquid state changes with temperature.
Reason : The volume of a solution changes with change in temperature.

52. **Assertion** : When methyl alcohol is added to water, boiling point of water increases.
Reason : When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

53. **Assertion** : When NaCl is added to water a depression in freezing point is observed.
Reason : The lowering of vapour pressure of a solution causes depression in the freezing point.

54. **Assertion** : When a solution is separated from the pure solvent by a semi-permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side.
Reason : Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

VI. Long Answer Type

55. Define the following modes of expressing the concentration of a solution. Which of these modes are independent of temperature and why?

(i) w/w (mass percentage)
(ii) *V*/*V* (volume percentage)
(iii) w/V (mass by volume percentage)
(iv) ppm. (parts per million)
(v) *x* (mole fraction)
(vi) M (Molarity)
(vii) m (Molality)

56. Using Raoult's law explain how the total vapour pressure over the solution is related to mole fraction of components in the following solutions.

(i) $CHCl_3$ (*l*) and CH_2Cl_2(*l*)
(ii) NaCl(s) and H_2O (*l*)

57. Explain the terms ideal and non-ideal solutions in the light of forces of interactions operating between molecules in liquid solutions.

58. Why is it not possible to obtain pure ethanol by fractional distillation? What general name is given to binary mixtures which show deviation from Raoult's law and whose components cannot be separated by fractional distillation. How many types of such mixtures are there?

59. When kept in water, raisin swells in size. Name and explain the phenomenon involved with the help of a diagram. Give three applications of the phenomenon.

60. Discuss biological and industrial importance of osmosis.

61. How can you remove the hard calcium carbonate layer of the egg without damaging its semiprermiable membrane? Can this egg be inserted into a bottle with a narrow neck without distorting its shape? Explain the process involved.

62. Why is the mass determined by measuring a colligative property in case of some solutes abnormal ? Discuss it with the help of Van't Hoff factor.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (i) 2. (iv) 3. (iii)

4. (ii), [**Hint :** If added substance dissolves, the solution is unsaturated. If it does not dissolve solution is saturated. If precipitation occurs solution is supersaturated.]

5. (iii)

6. (ii), [**Hint :** Body temperature of human beings remains constant.]

7. (i)	8. (ii)	9. (ii)	10. (i)	11. (iii)	12. (iv)
13. (i)	14. (i)	15. (ii)	16. (ii)	17. (i)	18. (ii)
19. (ii)	20. (iii)	21. (ii)	22. (i)	23. (i)	24. (iv)
25. (ii)	26. (iii)				

II. Multiple Choice Questions (Type-II)

27. (i), (ii)	28. (iii), (iv)	29. (i), (ii)	30. (i), (iii)	31. (ii), (iii)
32. (ii), (iii)	33. (ii), (iii)	34. (i), (iv)	35. (i), (ii)	

III. Short Answer Type

36. Since both the components are appearing in the distillate and composition of liquid and vapour is same, this shows that liquids have formed azeotropic mixture and hence cannot be separated at this stage by distillation.

37. NaCl is a non volatile solute, therefore, addition of NaCl to water lowers the vapour pressure of water. As a result boiling point of water increases. Methyl alcohol on the other hand is more volatile than water, therefore its addition increases, the total vapour pressure over the solution and a decrease in boiling point of water results.

38. A substance (solute) dissolves in a solvent if intermolecular interactions are similar in both the components; for example, polar solutes dissolve in polar solvents and non polar solutes in non polar solvents thus we can say "like dissolves like".

39. Molarity of a solution is defined as the number of moles of solute dissolved in one litre of solution. Since volume depends on temperature and undergoes a change with change in temperature, the molarity will also change with change in temperature. On the other hand, mass does not change with change in temperature, as a result other concentration terms given in the question remain unchanged by changing temperature. According to the definition of all these terms, mass of the solvent used for making the solution is related to the mass of solute.

40. Higher the value of Henry's law constant K_H, the lower is the solubility of the gas in the liquid.

41. At a given pressure the solubility of oxygen in water increases with decrease in temperature. Presence of more oxygen at lower temperature makes the aquatic species more comfortable in cold water.

42. Refer to the NCERT textbook for Class XII.

43. In pure liquid water the entire surface of liquid is occupied by the molecules of water. When a non volatile solute, for example glucose is dissolved in water, the fraction of surface covered by the solvent molecules gets reduced because some positions are occupied by glucose molecules. As a result number of solvent molecules escaping from the surface also gets reduced, consequently the vapour pressure of aqueous solution of glucose is reduced.

44. When salt is spread over snow covered roads, snow starts melting from the surface because of the depression in freezing point of water and it helps in clearing the roads.

45. Continuous sheets or films (natural or synthetic) which contain a network of submicroscopic holes or pores through which small solvent molecules like water can pass; but the passage of bigger molecules of solute is hindered, are known as semi permeable membrane.

46. Cellulose acetate.

IV. Matching Type

47. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b) (v) → (f) (vi) → (e)

48. (i) → (e) (ii) → (c) (iii) → (d) (iv) → (b) (v) → (a)

49. (i) → (c) (ii) → (e) (iii) → (d) (iv) → (a) (v) → (b)

50. (i) → (d) (ii) → (c) (iii) → (b) (iv) → (e) (v) → (a)

V. Assertion and Reason Type

51. (i) 52. (iv) 53. (i) 54. (ii)

VI. Long Answer Type

55. Refer to NCERT textbook for Class XII.

56. **Hint :** Discuss the following formulas

(i) for a binary solution having both components as volatile liquids, the total pressure will be

$$p = p_1 = x_1 p_1^0 + x_2 p_2^0$$
$$= x_1 p_1^0 + (1 - x_1) p_2^0$$
$$= (p_1^0 - p_2^0)\, x_1 + p_2^0$$

p = total vapour pressure

p_1 = partial vapour pressure of component 1

p_2 = partial vapour pressure of component 2.

(ii) For a solution containing non-volatile solute, the Raoult's law is applicable only to vaporisable component (1) and total vapour pressure is written as

$$p = p_1 = x_1 p_1^0$$

57. Refer to page 45 of NCERT textbook for Class XII.

58. See page 46 of NCERT textbook for Class XII.

59. [**Hint :** Explain it with the help of a diagram (Fig. 2.3) illustrating the osmosis of water into raisin.]

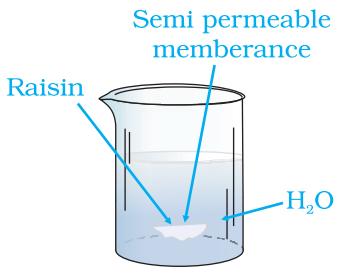


Fig. 2.3

60. **Hint :** The process of osmosis is of immense biological and industrial importance as is evident from the following examples :

(i) Movement of water from soil into plant roots and subsequently into upper portion of the plant is partly due to osmosis.

(ii) Preservation of meat against bacterial action by adding salt.

(iii) Preservation of fruits against bacterial action by adding sugar. Bacterium in canned fruit loses water through the process of osmosis, shrivels and dies.

(iv) Reverse osmosis is used for desalination of water.

61. **Hint :**

62. Certain compounds when dissolved in suitable solvents either dissociate or associate.

For example ethanoic acid dimerises in benzene due to hydrogen bonding, while in water, it dissociates and forms ions. As a result the number of chemical species in solution increases or decreases as compared to the number of chemical species of solute added to form the solution. Since the magnitude of colligative property depends on the number of solute particles, it is expected that the molar mass determined on the basis of

colligative properties will be either higher or lower than the expected value or the normal value and is called abnormal molar mass.

In order to account for the extent of dissociation or association of molecules in solution, Van't Hoff introduced a factor, *i*, known as the Van't Hoff factor. It can be defined as follows.

$$i = \frac{\text{Expected molar mass}}{\text{Abnormal molar mass}}$$

$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$= \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$$

Unit

3

ELECTROCHEMISTRY

I. Multiple Choice Questions (Type-I)

1. Which cell will measure standard electrode potential of copper electrode?

(i) $Pt\,(s)\,|\,H_2\,(g,0.1\ bar)\,|\,H^+(aq.,1\ M)\,||\,Cu^{2+}(aq.,1M)\,|\,Cu$

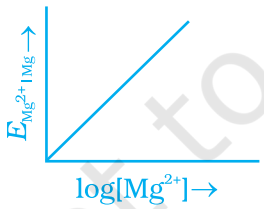
(ii) $Pt(s)\,|\,H_2\,(g,\ 1\ bar)\,|\,H^+(aq.,1\ M)\,||\,Cu^{2+}(aq.,2\ M)\,|\,Cu$

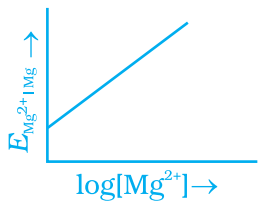
(iii) $Pt(s)\,|\,H_2\,(g,\ 1\ bar)\,|\,H^+(aq.,1\ M)\,||\,Cu^{2+}(aq.,1\ M)\,|\,Cu$

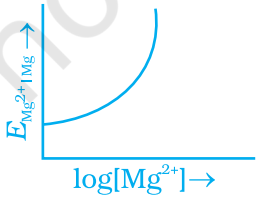
(iv) $Pt(s)\,|\,H_2\,(g,\ 1\ bar)\,|\,H^+(aq.,0.1\ M)\,||\,Cu^{2+}(aq.,1\ M)\,|\,Cu$

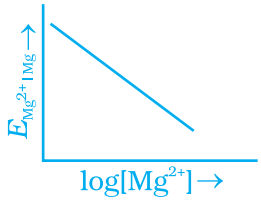
2. Electrode potential for Mg electrode varies according to the equation

$E_{Mg^{2+}|\,Mg} = E^{\ominus}_{Mg^{2+}|\,Mg} - \dfrac{0.059}{2}\log\dfrac{1}{[Mg^{2+}]}$. The graph of $E_{Mg^{2+}|\,Mg}$ vs $\log\,[Mg^{2+}]$ is

(i) 

(ii) 

(iii) 

(iv) 

3. Which of the following statement is correct?

(i) E_{Cell} and $\Delta_r G$ of cell reaction both are extensive properties.

(ii) E_{Cell} and $\Delta_r G$ of cell reaction both are intensive properties.

(iii) E_{Cell} is an intensive property while $\Delta_r G$ of cell reaction is an extensive property.

(iv) E_{Cell} is an extensive property while $\Delta_r G$ of cell reaction is an intensive property.

4. The difference between the electrode potentials of two electrodes when no current is drawn through the cell is called _____.

(i) Cell potential

(ii) Cell emf

(iii) Potential difference

(iv) Cell voltage

5. Which of the following statement is **not** correct about an inert electrode in a cell?

(i) It does not participate in the cell reaction.

(ii) It provides surface either for oxidation or for reduction reaction.

(iii) It provides surface for conduction of electrons.

(iv) It provides surface for redox reaction.

6. An electrochemical cell can behave like an electrolytic cell when _____.

(i) $E_{cell} = 0$

(ii) $E_{cell} > E_{ext}$

(iii) $E_{ext} > E_{cell}$

(iv) $E_{cell} = E_{ext}$

7. Which of the statements about solutions of electrolytes is **not** correct?

(i) Conductivity of solution depends upon size of ions.

(ii) Conductivity depends upon viscosiy of solution.

(iii) Conductivity does not depend upon solvation of ions present in solution.

(iv) Conductivity of solution increases with temperature.

8. Using the data given below find out the strongest reducing agent.

$E^{\ominus}_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33V$ $E^{\ominus}_{Cl_2/Cl^-} = 1.36V$

$E^{\ominus}_{MnO_4^-/Mn^{2+}} = 1.51V$ $E^{\ominus}_{Cr^{3+}/Cr} = -0.74V$

(i) Cl^-

(ii) Cr

(iii) Cr^{3+}

(iv) Mn^{2+}

9. Use the data given in Q.8 and find out which of the following is the strongest oxidising agent.

(i) Cl^-

(ii) Mn^{2+}

(iii) MnO_4^-

(iv) Cr^{3+}

10. Using the data given in Q.8 find out in which option the order of reducing power is correct.

(i) $Cr^{3+} < Cl^- < Mn^{2+} < Cr$

(ii) $Mn^{2+} < Cl^- < Cr^{3+} < Cr$

(iii) $Cr^{3+} < Cl^- < Cr_2O_7^{2-} < MnO_4^-$

(iv) $Mn^{2+} < Cr^{3+} < Cl^- < Cr$

11. Use the data given in Q.8 and find out the most stable ion in its reduced form.

(i) Cl^-

(ii) Cr^{3+}

(iii) Cr

(iv) Mn^{2+}

12. Use the data of Q.8 and find out the most stable oxidised species.

(i) Cr^{3+}

(ii) MnO_4^-

(iii) $Cr_2O_7^{2-}$

(iv) Mn^{2+}

13. The quantity of charge required to obtain one mole of aluminium from Al_2O_3 is _____.

(i) 1F

(ii) 6F

(iii) 3F

(iv) 2F

14. The cell constant of a conductivity cell _____.

(i) changes with change of electrolyte.

(ii) changes with change of concentration of electrolyte.

(iii) changes with temperature of electrolyte.

(iv) remains constant for a cell.

15. While charging the lead storage battery _____.

(i) $PbSO_4$ anode is reduced to Pb.

(ii) $PbSO_4$ cathode is reduced to Pb.

(iii) $PbSO_4$ cathode is oxidised to Pb.

(iv) $PbSO_4$ anode is oxidised to PbO_2.

16. $\Lambda^0_{m\ (NH_4OH)}$ is equal to _____.

(i) $\Lambda^0_{m\ (NH_4OH)} + \Lambda^0_{m\ (NH_4Cl)} - \Lambda^0_{(HCl)}$

(ii) $\Lambda^0_{m\ (NH_4Cl)} + \Lambda^0_{m(NaOH)} - \Lambda^0_{(NaCl)}$

(iii) $\Lambda^0_{m\ (NH_4Cl)} + \Lambda^0_{m(NaCl)} - \Lambda^0_{(NaOH)}$

(iv) $\Lambda^0_{m\ (NaOH)} + \Lambda^0_{m(NaCl)} - \Lambda^0_{(NH_4Cl)}$

17. In the electrolysis of aqueous sodium chloride solution which of the half cell reaction will occur at anode?

(i) $Na^+ (aq) + e^- \longrightarrow Na\ (s)$; $E^{\ominus}_{Cell} = -2.71V$

(ii) $2H_2O\ (l) \longrightarrow O_2\ (g) + 4H^+ (aq) + 4e^-$; $E^{\ominus}_{Cell} = 1.23V$

(iii) $H^+ (aq) + e^- \longrightarrow \frac{1}{2} H_2\ (g)$; $E^{\ominus}_{Cell} = 0.00\ V$

(iv) $Cl^- (aq) \longrightarrow \frac{1}{2} Cl_2\ (g) + e^-$; $E^{\ominus}_{Cell} = 1.36\ V$

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more than two options may be correct.

18. The positive value of the standard electrode potential of Cu^{2+}/Cu indicates that _____.

(i) this redox couple is a stronger reducing agent than the H^+/H_2 couple.

(ii) this redox couple is a stronger oxidising agent than H^+/H_2.

(iii) Cu can displace H_2 from acid.

(iv) Cu cannot displace H_2 from acid.

19. $E^{\ominus}_{Cell}$ for some half cell reactions are given below. On the basis of these mark the correct answer.

(a) $H^+ (aq) + e^- \longrightarrow \frac{1}{2} H_2\ (g)$; $E^{\ominus}_{Cell} = 0.00V$

(b) $2H_2O\,(l) \longrightarrow O_2\,(g) + 4H^+\,(aq) + 4e^-$; $E^{\ominus}_{Cell} = 1.23V$

(c) $2SO_4^{2-}\,(aq) \longrightarrow S_2O_8^{2-}\,(aq) + 2e^-$; $E^{\ominus}_{Cell} = 1.96\ V$

(i) In dilute sulphuric acid solution, hydrogen will be reduced at cathode.

(ii) In concentrated sulphuric acid solution, water will be oxidised at anode.

(iii) In dilute sulphuric acid solution, water will be oxidised at anode.

(iv) In dilute sulphuric acid solution, SO_4^{2-} ion will be oxidised to tetrathionate ion at anode.

20. $E^{\ominus}_{Cell} = 1.1V$ for Daniel cell. Which of the following expressions are correct description of state of equilibrium in this cell?

(i) $1.1 = K_c$

(ii) $\frac{2.303RT}{2F}\log K_c = 1.1$

(iii) $\log K_c = \frac{2.2}{0.059}$

(iv) $\log K_c = 1.1$

21. Conductivity of an electrolytic solution depends on _____.

(i) nature of electrolyte.

(ii) concentration of electrolyte.

(iii) power of AC source.

(iv) distance between the electrodes.

22. $\Lambda^0_m H_2O$ is equal to _____.

(i) $\Lambda^0_{m\,(HCl)} + \Lambda^0_{m\,(NaOH)} - \Lambda^0_{m\,(NaCl)}$

(ii) $\Lambda^0_{m\,(HNO_3)} + \Lambda^0_{m\,(NaNO_3)} - \Lambda^0_{m\,(NaOH)}$

(iii) $\Lambda^0_{(HNO_3)} + \Lambda^0_{m(NaOH)} - \Lambda^0_{m\,(NaNO_3)}$

(iv) $\Lambda^0_{m\,(NH_4OH)} + \Lambda^0_{m(HCl)} - \Lambda^0_{m\,(NH_4Cl)}$

23. What will happen during the electrolysis of aqueous solution of $CuSO_4$ by using platinum electrodes?

(i) Copper will deposit at cathode.

(ii) Copper will deposit at anode.

(iii) Oxygen will be released at anode.

(iv) Copper will dissolve at anode.

24. What will happen during the electrolysis of aqueous solution of $CuSO_4$ in the presence of Cu electrodes?

(i) Copper will deposit at cathode.

(ii) Copper will dissolve at anode.

(iii) Oxygen will be released at anode.

(iv) Copper will deposit at anode.

25. Conductivity κ, is equal to _____.

(i) $\frac{1}{R}\frac{l}{A}$

(ii) $\frac{G^*}{R}$

(iii) Λ_m

(iv) $\frac{l}{A}$

26. Molar conductivity of ionic solution depends on _____.

(i) temperature.

(ii) distance between electrodes.

(iii) concentration of electrolytes in solution.

(iv) surface area of electrodes.

27. For the given cell, $Mg|Mg^{2+}||Cu^{2+}|Cu$

(i) Mg is cathode

(ii) Cu is cathode

(iii) The cell reaction is $Mg + Cu^{2+} \longrightarrow Mg^{2+} + Cu$

(iv) Cu is the oxidising agent

III. Short Answer Type

28. Can absolute electrode potential of an electrode be measured?

29. Can $E^{\ominus}_{Cell}$ or $\Delta_r G^{\ominus}$ for cell reaction ever be equal to zero?

30. Under what condition is $E_{Cell} = 0$ or $\Delta_r G = 0$?

31. What does the negative sign in the expression $E^{\ominus}_{Zn^{2+}/Zn} = -0.76\ V$ mean?

32. Aqueous copper sulphate solution and aqueous silver nitrate solution are electrolysed by 1 ampere current for 10 minutes in separate electrolytic cells. Will the mass of copper and silver deposited on the cathode be same or different? Explain your answer.

33. Depict the galvanic cell in which the cell reaction is $Cu + 2Ag^{+} \longrightarrow 2Ag + Cu^{2+}$

34. Value of standard electrode potential for the oxidation of Cl^{-} ions is more positive than that of water, even then in the electrolysis of aqueous sodium chloride, why is Cl^{-} oxidised at anode instead of water?

35. What is electrode potential?

36. Consider the following diagram in which an electrochemical cell is coupled to an electrolytic cell. What will be the polarity of electrodes 'A' and 'B' in the electrolytic cell?

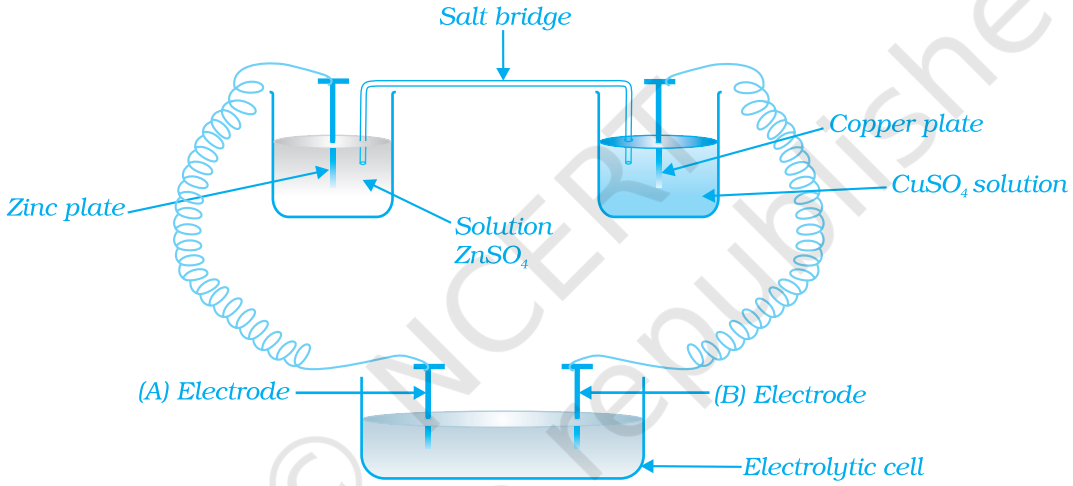


Fig. *3.1*

37. Why is alternating current used for measuring resistance of an electrolytic solution?

38. A galvanic cell has electrical potential of 1.1V. If an opposing potential of 1.1V is applied to this cell, what will happen to the cell reaction and current flowing through the cell?

39. How will the pH of brine (aq. NaCl solution) be affected when it is electrolysed?

40. Unlike dry cell, the mercury cell has a constant cell potential throughout its useful life. Why?

41. Solutions of two electrolytes 'A' and 'B' are diluted. The Λ_m of 'B' increases 1.5 times while that of A increases 25 times. Which of the two is a strong electrolyte? Justify your answer.

42. When acidulated water (dil.H_2SO_4 solution) is electrolysed, will the pH of the solution be affected? Justify your answer.

43. In an aqueous solution how does specific conductivity of electrolytes change with addition of water?

44. Which reference electrode is used to measure the electrode potential of other electrodes?

45. Consider a cell given below

$Cu \mid Cu^{2+} \mid\mid Cl^- \mid Cl_2, Pt$

Write the reactions that occur at anode and cathode

46. Write the Nernst equation for the cell reaction in the Daniel cell. How will the E_{Cell} be affected when concentration of Zn^{2+} ions is increased?

47. What advantage do the fuel cells have over primary and secondary batteries?

48. Write the cell reaction of a lead storage battery when it is discharged. How does the density of the electrolyte change when the battery is discharged?

49. Why on dilution the Λ_m of CH_3COOH increases drastically, while that of CH_3COONa increases gradually?

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

50. Match the terms given in Column I with the units given in Column II.

Column I		Column II	
(i)	$\wedge_m$	(a)	S cm^{-1}
(ii)	E_{Cell}	(b)	m^{-1}
(iii)	κ	(c)	S cm^2 mol^{-1}
(iv)	G*	(d)	V

51. Match the terms given in Column I with the items given in Column II.

Column I		Column II	
(i)	Λ_m	(a)	intensive property
(ii)	$E^{\ominus}_{Cell}$	(b)	depends on number of ions/volume
(iii)	κ	(c)	extensive property
(iv)	$\Delta_r G_{Cell}$	(d)	increases with dilution

52. Match the items of Column I and Column II.

Column I		Column II	
(i)	Lead storage battery	(a)	maximum efficiency

(ii)	Mercury cell	(b)	prevented by galvanisation
(iii)	Fuel cell	(c)	gives steady potential
(iv)	Rusting	(d)	Pb is anode, PbO_2 is cathode

53. Match the items of Column I and Column II.

Column I		**Column II**	
(i)	κ	(a)	$I \times t$
(ii)	Λ_m	(b)	Λ_m / Λ_m^0
(iii)	α	(c)	$\frac{\kappa}{c}$
(iv)	Q	(d)	$\frac{G^*}{R}$

54. Match the items of Column I and Column II.

Column I		**Column II**	
(i)	Lechlanche cell	(a)	cell reaction $2H_2 + O_2 \longrightarrow 2H_2O$
(ii)	Ni–Cd cell	(b)	does not involve any ion in solution and is used in hearing aids.
(iii)	Fuel cell	(c)	rechargeable
(iv)	Mercury cell	(d)	reaction at anode, $Zn \longrightarrow Zn^{2+} + 2e^-$
		(e)	converts energy of combustion into electrical energy

55. Match the items of Column I and Column II on the basis of data given below:

$E^{\ominus}_{F_2/F^-} = 2.87V$, $E^{\ominus}_{Li^+/Li} = -3.5V$, $E^{\ominus}_{Au^{3+}/Au} = 1.4V$, $E^{\ominus}_{Br_2/Br^-} = 1.09V$

Column I		**Column II**	
(i)	F_2	(a)	metal is the strongest reducing agent
(ii)	Li	(b)	metal ion which is the weakest oxidising agent
(iii)	Au^{3+}	(c)	non metal which is the best oxidising agent
(iv)	Br^-	(d)	unreactive metal
(v)	Au	(e)	anion that can be oxidised by Au^{3+}
(vi)	Li^+	(f)	anion which is the weakest reducing agent
(vii)	F^-	(g)	metal ion which is an oxidising agent

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are true and the reason is the correct explanation of assertion.

(ii) Both assertion and reason are true and the reason is not the correct explanation of assertion.

(iii) Assertion is true but the reason is false.

(iv) Both assertion and reason are false.

(v) Assertion is false but reason is true.

56. **Assertion** : Cu is less reactive than hydrogen.

Reason : $E^{\ominus}_{Cu^{2+}/Cu}$ is negative.

57. **Assertion** : E_{Cell} should have a positive value for the cell to function.

Reason : $E_{cathode} < E_{anode}$

58. **Assertion** : Conductivity of all electrolytes decreases on dilution.

Reason : On dilution number of ions per unit volume decreases.

59. **Assertion** : Λ_m for weak electrolytes shows a sharp increase when the electrolytic solution is diluted.

Reason : For weak electrolytes degree of dissociation increases with dilution of solution.

60. **Assertion** : Mercury cell does not give steady potential.

Reason : In the cell reaction, ions are not involved in solution.

61. **Assertion** : Electrolysis of NaCl solution gives chlorine at anode instead of O_2.

Reason : Formation of oxygen at anode requires overvoltage.

62. **Assertion** : For measuring resistance of an ionic solution an AC source is used.

Reason : Concentration of ionic solution will change if DC source is used.

63. **Assertion** : Current stops flowing when $E_{Cell} = 0$.

Reason : Equilibrium of the cell reaction is attained.

64. **Assertion** : $E_{Ag^+/Ag}$ increases with increase in concentration of Ag^+ ions.

Reason : $E_{Ag^+/Ag}$ has a positive value.

65. **Assertion** : Copper sulphate can be stored in zinc vessel.

Reason : Zinc is less reactive than copper.

VI. Long Answer Type

66. Consider the Fig. 3.2 and answer the following questions.

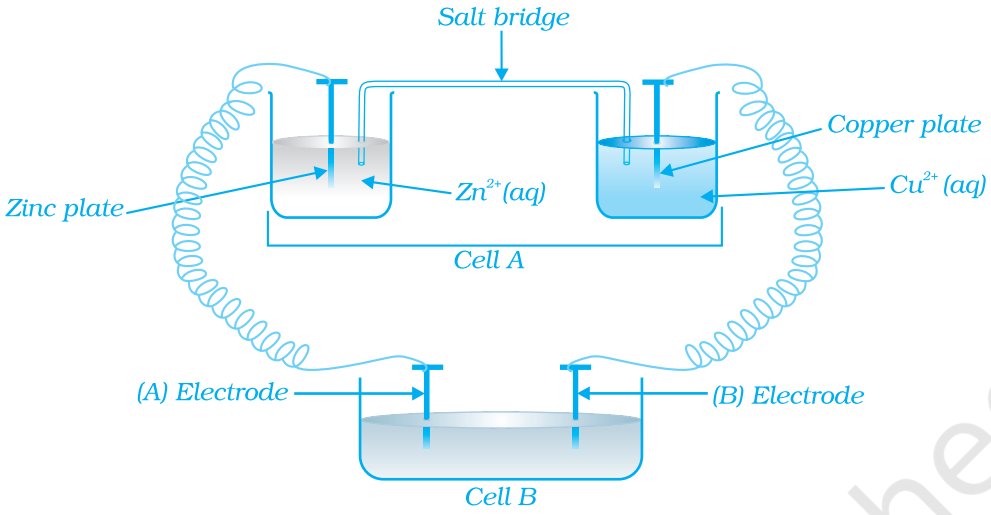


Fig. *3.2*

(i) Cell 'A' has $E_{Cell} = 2V$ and Cell 'B' has $E_{Cell} = 1.1V$ which of the two cells 'A' or 'B' will act as an electrolytic cell. Which electrode reactions will occur in this cell?

(ii) If cell 'A' has $E_{Cell} = 0.5V$ and cell 'B' has $E_{Cell} = 1.1V$ then what will be the reactions at anode and cathode?

67. Consider Fig. 3.2 and answer the questions (i) to (vi) given below.

(i) Redraw the diagram to show the direction of electron flow.

(ii) Is silver plate the anode or cathode?

(iii) What will happen if salt bridge is removed?

(iv) When will the cell stop functioning?

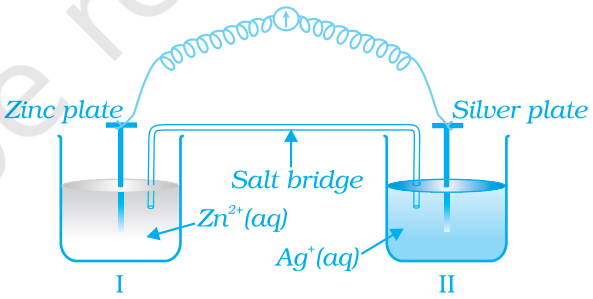


Fig. *3.3*

(v) How will concentration of Zn^{2+} ions and Ag^{+} ions be affected when the cell functions?

(vi) How will the concentration of Zn^{2+} ions and Ag^{+} ions be affected after the cell becomes 'dead'?

68. What is the relationship between Gibbs free energy of the cell reaction in a galvanic cell and the emf of the cell? When will the maximum work be obtained from a galvanic cell?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)	2. (ii)	3. (iii)	4. (ii)	5. (iv)	6. (iii)
7. (iii)	8. (ii)	9. (iii)	10. (ii)	11. (iv)	12. (i)
13. (iii)	14. (iv)	15. (i)	16. (ii)	17. (ii)	

II. Multiple Choice Questions (Type-II)

18. (ii), (iv)	19. (i), (iii)	20. (ii), (iii)	21. (i), (ii)
22. (i), (iv)	23. (i), (iii)	24. (i), (ii)	25. (i), (ii)
26. (i), (iii)	27. (ii), (iii)		

III. Short Answer Type

28. No

29. No

30. When the cell reaction reaches equilibrium.

31. It means that Zn is more reactive than hydrogen. When zinc electrode will be connected to SHE, Zn will get oxidised and H^+ will get reduced.

32. Different, see the NCERT textbook, page no. 84.

33. $Cu \mid Cu^{2+} \mid\mid Ag^+ \mid Ag$

34. Under the conditions of electrolysis of aqueous sodium chloride, oxidation of water at anode requires overpotential hence Cl^- is oxidised instead of water.

35. See NCERT textbook, page no. 65

36. 'A' will have negative polarity

    'B' will have positive polarity

37. Alternating current is used to prevent electrolysis so that concentration of ions in the solution remains constant.

38. See NCERT textbook, page no. 64

39. The pH of the solution will rise as NaOH is formed in the electrolytic cell.

40. Ions are not involved in the overall cell reaction of mercury cells.

41. Electrolyte 'B' is strong as on dilution the number of ions remains the same, only interionic attraction decreases therefore increase in $\wedge_m$ is small.

42. pH of the solution will not be affected as $[H^+]$ remains constant.

At anode : $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

At cathode $4H^+ + 4e^- \longrightarrow 2H_2$

43. Conductivity decreases because number of ions per unit volume decreases.

44. Standard hydrogen electrode is the reference electrode whose electrode potential is taken to be zero. The electrode potential of other electrodes is measured with respect to it.

45. Anode : $Cu \longrightarrow Cu^{2+} + 2e^-$

Cathode : $Cl_2 + 2e^- \longrightarrow 2Cl^-$

Cu is anode as it is getting oxidised.

Cl_2 is cathode as it is getting reduced.

46. $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$

$$E_{Cell} = E^{\ominus}_{Cell} - \frac{0.059}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

E_{Cell} decreases when concentration of Zn^{2+} ions, $[Zn^{2+}]$ increases.

47. Primary batteries contain a limited amount of reactants and are discharged when the reactants have been consumed. Secondary batteries can be recharged but take a long time to recharge. Fuel cell runs continuously as long as the reactants are supplied to it and products are removed continuously.

48. $Pb + PbO_2 + 2H_2SO_4 \longrightarrow 2PbSO_4 + 2H_2O$

Density of electrolyte decreases as water is formed and sulphuric acid is consumed as the product during discharge of the battery.

49. In the case of CH_3COOH, which is a weak electrolyte, the number of ions increase on dilution due to an increase in degree of dissociation.

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

In the case of strong electrolyte the number of ions remains the same but the interionic attraction decreases.

IV. Matching Type

50. (i) → (c) (ii) → (d) (iii) → (a) (iv) → (b)

51. (i) → (d) (ii) → (a) (iii) → (b) (iv) → (c)

52. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b)

53. (i) → (d) (ii) → (c) (iii) → (b) (iv) → (a)

54. (i) → (d) (ii) → (c) (iii) → (a), (e) (iv) → (b)

55. (i) → (c) (ii) → (a) (iii) → (g) (iv) → (e)
(v) → (d) (vi) → (b) (vii) → (g) (f)

V. Assertion and Reason Type

56. (iii) 57. (iii) 58. (i) 59. (i) 60. (v)

61. (i) 62. (i) 63. (i) 64. (ii) 65. (iv)

VI. Long Answer Type

66. (i) Cell 'B' will act as electrolytic cell as it has lower emf

∴ The electrode reactions will be:

$Zn^{2+} + 2e^- \longrightarrow Zn$ at cathode

$Cu \longrightarrow Cu^{2+} + 2e^-$ at anode

(ii) Now cell 'B' acts as galvanic cell as it has higher emf and will push electrons into cell 'A'.

The electrode reaction will be:

At anode : $Zn \longrightarrow Zn^{2+} + 2e^-$

At cathode : $Cu^{2+} + 2e^- \longrightarrow Cu$

67. **Hint :** (i) Electrons move from Zn to Ag.

(ii) Ag is the cathode.

(iii) Cell will stop functioning.

(iv) When $E_{Cell} = 0$.

(v) Concentration of Zn^{2+} ions will increase and concentration of Ag^+ ions will decrease

(vi) When $E_{cell} = 0$ equilibrium is reached and concentration of Zn^{2+} ions and Ag^+ ions will not change.

Unit

4

CHEMICAL KINETICS

I. Multiple Choice Questions (Type-I)

1. The role of a catalyst is to change _____.

(i) gibbs energy of reaction.

(ii) enthalpy of reaction.

(iii) activation energy of reaction.

(iv) equilibrium constant.

2. In the presence of a catalyst, the heat evolved or absorbed during the reaction _____.

(i) increases.

(ii) decreases.

(iii) remains unchanged.

(iv) may increase or decrease.

3. Activation energy of a chemical reaction can be determined by _____.

(i) determining the rate constant at standard temperature.

(ii) determining the rate constants at two temperatures.

(iii) determining probability of collision.

(iv) using catalyst.

4. Consider Fig. 4.1 and mark the correct option.

(i) Activation energy of forward reaction is $E_1 + E_2$ and product is less stable than reactant.

(ii) Activation energy of forward reaction is E_1+E_2 and product is more stable than reactant.

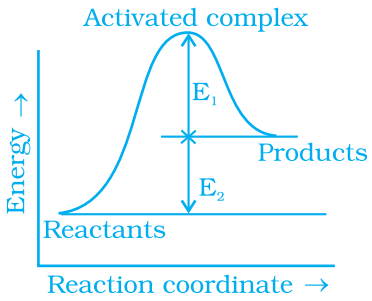


Fig. *4.1*

(iii) Activation energy of both forward and backward reaction is E_1+E_2 and reactant is more stable than product.

(iv) Activation energy of backward reaction is E_1 and product is more stable than reactant.

5. Consider a first order gas phase decomposition reaction given below :

$$A(g) \longrightarrow B(g) + C(g)$$

The initial pressure of the system before decomposition of A was p_i. After lapse of time 't', total pressure of the system increased by x units and became 'p_t' The rate constant k for the reaction is given as _____.

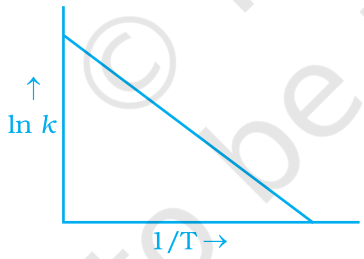
(i) $k = \frac{2.303}{t} \log \frac{p_i}{p_i - x}$

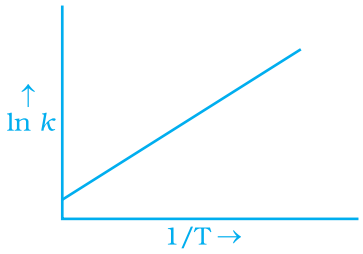
(ii) $k = \frac{2.303}{t} \log \frac{p_i}{2p_i - p_t}$

(iii) $k = \frac{2.303}{t} \log \frac{p_i}{2p_i + p_t}$

(iv) $k = \frac{2.303}{t} \log \frac{p_i}{p_i + x}$

6. According to Arrhenius equation rate constant k is equal to $A\, e^{-E_a/RT}$. Which of the following options represents the graph of ln k vs $\frac{1}{T}$?

(i)


(ii)


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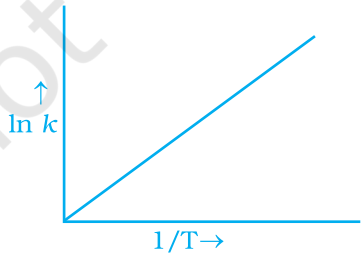

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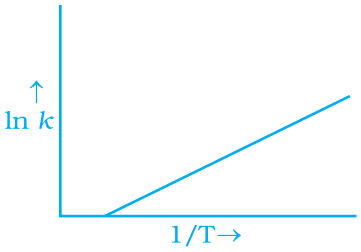


7. Consider the Arrhenius equation given below and mark the correct option.

$$k = A\, e^{-E_a / RT}$$

(i) Rate constant increases exponentially with increasing activation energy and decreasing temperature.

(ii) Rate constant decreases exponentially with increasing activation energy and decreasing temperature.

(iii) Rate constant increases exponentially with decreasing activation energy and decreasing temperature.

(iv) Rate constant increases exponentially with decreasing activation energy and increasing temperature.

8. A graph of volume of hydrogen released vs time for the reaction between zinc and dil.HCl is given in Fig. 4.2. On the basis of this mark the correct option.

(i) Average rate upto 40s is $\frac{V_3 - V_2}{40}$

(ii) Average rate upto 40 seconds is $\frac{V_3 - V_2}{40 - 30}$

(iii) Average rate upto 40 seconds is $\frac{V_3}{40}$

(iv) Average rate upto 40 seconds is $\frac{V_3 - V_1}{40 - 20}$

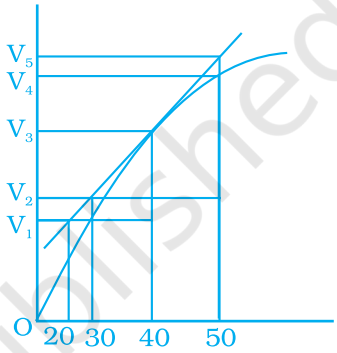


Fig. *4.2*

9. Which of the following statements is **not** correct about order of a reaction.

(i) The order of a reaction can be a fractional number.

(ii) Order of a reaction is experimentally determined quantity.

(iii) The order of a reaction is always equal to the sum of the stoichiometric coefficients of reactants in the balanced chemical equation for a reaction.

(iv) The order of a reaction is the sum of the powers of molar concentration of the reactants in the rate law expression.

10. Consider the graph given in Fig. 4.2. Which of the following options does **not** show instantaneous rate of reaction at 40th second?

(i) $\frac{V_5 - V_2}{50 - 30}$

(ii) $\frac{V_4 - V_2}{50 - 30}$

(iii) $\frac{V_3 - V_2}{40 - 30}$

(iv) $\frac{V_3 - V_1}{40 - 20}$

11. Which of the following statements is correct?

(i) The rate of a reaction decreases with passage of time as the concentration of reactants dereases.

(ii) The rate of a reaction is same at any time during the reaction.

(iii) The rate of a reaction is independent of temperature change.

(iv) The rate of a reaction decreases with increase in concentration of reactant(s).

12. Which of the following expressions is correct for the rate of reaction given below?

$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \longrightarrow 3Br_2(aq) + 3H_2O(l)$

(i) $\frac{\Delta[Br^-]}{\Delta t} = 5\frac{\Delta[H^+]}{\Delta t}$

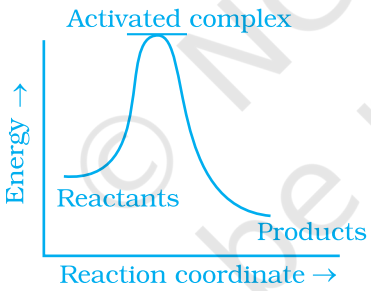
(ii) $\frac{\Delta[Br^-]}{\Delta t} = \frac{6}{5}\frac{\Delta[H^+]}{\Delta t}$

(iii) $\frac{\Delta[Br^-]}{\Delta t} = \frac{5}{6}\frac{\Delta[H^+]}{\Delta t}$

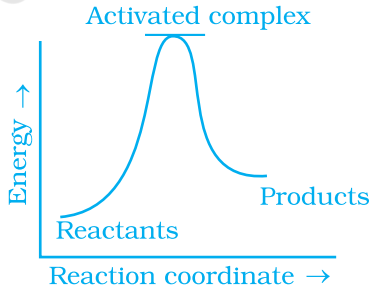
(iv) $\frac{\Delta[Br^-]}{\Delta t} = 6\frac{\Delta[H^+]}{\Delta t}$

13. Which of the following graphs represents exothermic reaction?

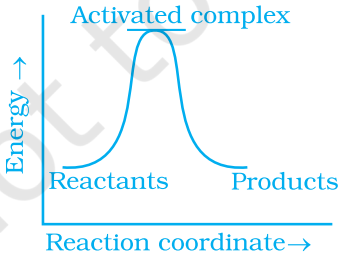
(a)



(b)



(c)



(i) (a) only

(ii) (b) only

(iii) (c) only

(iv) (a) and (b)

14. Rate law for the reaction A + 2B ⟶ C is found to be

$$\text{Rate} = k[A][B]$$

Concentration of reactant 'B' is doubled, keeping the concentration of 'A' constant, the value of rate constant will be_____.

(i) the same

(ii) doubled

(iii) quadrupled

(iv) halved

15. Which of the following statements is **incorrect** about the collison theory of chemical reaction?

(i) It considers reacting molecules or atoms to be hard spheres and ignores their structural features.

(ii) Number of effective collisions determines the rate of reaction.

(iii) Collision of atoms or molecules possessing sufficient threshold energy results into the product formation.

(iv) Molecules should collide with sufficient threshold energy and proper orientation for the collision to be effective.

16. A first order reaction is 50% completed in 1.26×10^{14} s. How much time would it take for 100% completion?

(i) 1.26×10^{15} s

(ii) 2.52×10^{14} s

(iii) 2.52×10^{28} s

(iv) infinite

17. Compounds 'A' and 'B' react according to the following chemical equation.

$$A(g) + 2B(g) \longrightarrow 2C(g)$$

Concentration of either 'A' or 'B' were changed keeping the concentrations of one of the reactants constant and rates were measured as a function of initial concentration. Following results were obtained. Choose the correct option for the rate equations for this reaction.

Experiment	**Initial concentration of [A]/mol L^{-1}**	**Initial concentration of [B]/mol L^{-1}**	**Initial rate of formation of [C]/mol L^{-1} s^{-1}**
1.	0.30	0.30	0.10
2.	0.30	0.60	0.40
3.	0.60	0.30	0.20

(i) Rate = $k[A]^2[B]$

(ii) Rate = $k[A][B]^2$

(iii) Rate = $k[A][B]$

(iv) Rate = $k[A]^2[B]^0$

18. Which of the following statement is **not** correct for the catalyst?

(i) It catalyses the forward and backward reaction to the same extent.

(ii) It alters ΔG of the reaction.

(iii) It is a substance that does not change the equilibrium constant of a reaction.

(iv) It provides an alternate mechanism by reducing activation energy between reactants and products.

19. The value of rate constant of a pseudo first order reaction _____.

(i) depends on the concentration of reactants present in small amount.

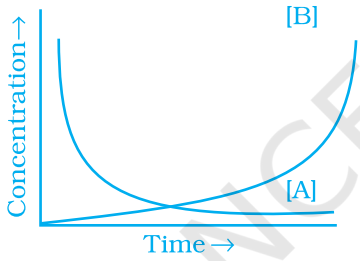
(ii) depends on the concentration of reactants present in excess.

(iii) is independent of the concentration of reactants.

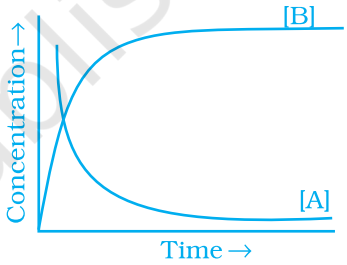
(iv) depends only on temperature.

20. Consider the reaction A $\rightleftharpoons$ B. The concentration of both the reactants and the products varies exponentially with time. Which of the following figures correctly describes the change in concentration of reactants and products with time?

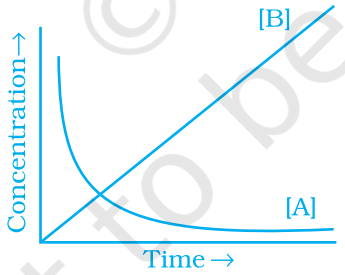
(i)



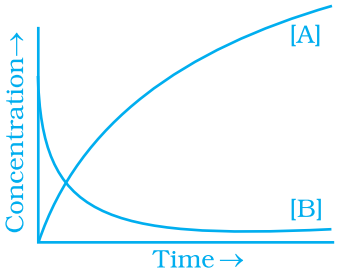
(ii)



(iii)



(iv)



II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

21. Rate law cannot be determined from balanced chemical equation if _____.

(i) reverse reaction is involved.

(ii) it is an elementary reaction.

(iii) it is a sequence of elementary reactions.

(iv) any of the reactants is in excess.

22. Which of the following statements are applicable to a balanced chemical equation of an elementary reaction?

(i) Order is same as molecularity.

(ii) Order is less than the molecularity.

(iii) Order is greater than the molecularity.

(iv) Molecularity can never be zero.

23. In any unimolecular reaction _____.

(i) only one reacting species is involved in the rate determining step.

(ii) the order and the molecularity of slowest step are equal to one.

(iii) the molecularity of the reaction is one and order is zero.

(iv) both molecularity and order of the reaction are one.

24. For a complex reaction _____.

(i) order of overall reaction is same as molecularity of the slowest step.

(ii) order of overall reaction is less than the molecularity of the slowest step.

(iii) order of overall reaction is greater than molecularity of the slowest step.

(iv) molecularity of the slowest step is never zero or non interger.

25. At high pressure the following reaction is zero order.

$$2NH_3(g) \xrightarrow[\text{Platinum catalyst}]{1130\ K} N_2(g) + 3H_2(g)$$

Which of the following options are correct for this reaction?

(i) Rate of reaction = Rate constant

(ii) Rate of the reaction depends on concentration of ammonia.

(iii) Rate of decomposition of ammonia will remain constant until ammonia disappears completely.

(iv) Further increase in pressure will change the rate of reaction.

26. During decomposition of an activated complex

(i) energy is always released

(ii) energy is always absorbed

(iii) energy does not change

(iv) reactants may be formed

28. According to Maxwell Boltzmann distributon of energy, _____.

(i) the fraction of molecules with most probable kinetic energy decreases at higher temperatures.

(ii) the fraction of molecules with most probable kinetic energy increases at higher temperatures.

(iii) most probable kinetic energy increases at higher temperatures.

(iv) most probable kinetic energy decreases at higher temperatures.

28. In the graph showing Maxwell Boltzman distribution of energy, _____.

(i) area under the curve must not change with increase in temperature.

(ii) area under the curve increases with increase in temperature.

(iii) area under the curve decreases with increase in temperature.

(iv) with increase in temperature curve broadens and shifts to the right hand side.

29. Which of the following statements are in accordance with the Arrhenius equation?

(i) Rate of a reaction increases with increase in temperature.

(ii) Rate of a reaction increases with decrease in activation energy.

(iii) Rate constant decreases exponentially with increase in temperature.

(iv) Rate of reaction decreases with decrease in activation energy.

30. Mark the **incorrect** statements.

(i) Catalyst provides an alternative pathway to reaction mechanism.

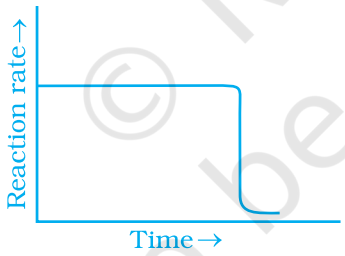
(ii) Catalyst raises the activation energy.

(iii) Catalyst lowers the activation energy.

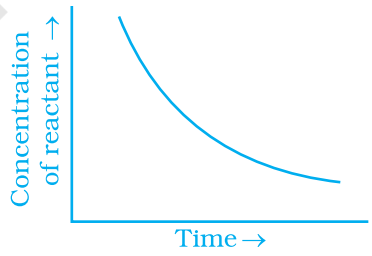
(iv) Catalyst alters enthalpy change of the reaction.

31. Which of the following graphs is correct for a zero order reaction?

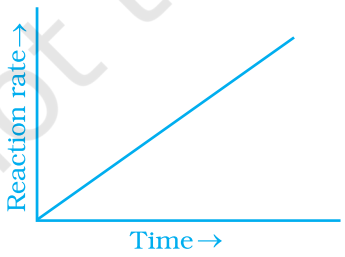
(i)



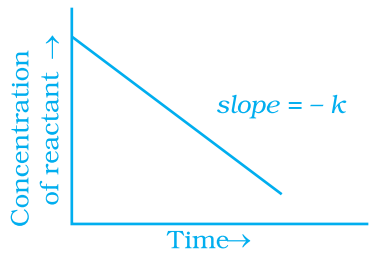
(ii)



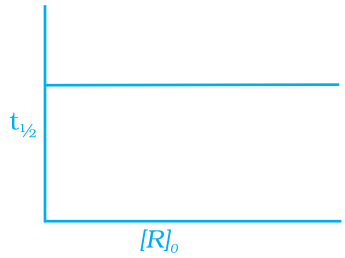
(iii)

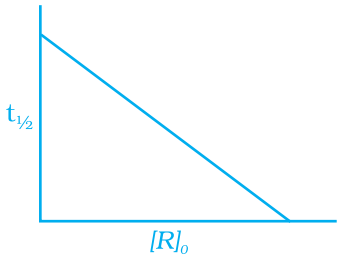


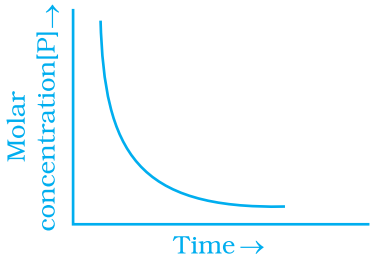
(iv)

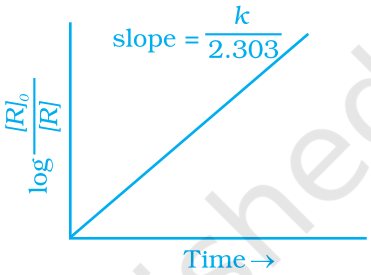


32. Which of the following graphs is correct for a first order reaction?

(i) 

(ii) 

(iii) 

(iv) 

III. Short Answer Type

33. State a condition under which a bimolecular reaction is kinetically first order reaction.

34. Write the rate equation for the reaction $2A + B \longrightarrow C$ if the order of the reaction is zero.

35. How can you determine the rate law of the following reaction?

$2NO\ (g) + O_2\ (g) \longrightarrow 2NO_2\ (g)$

36. For which type of reactions, order and molecularity have the same value?

37. In a reaction if the concentration of reactant A is tripled, the rate of reaction becomes twenty seven times. What is the order of the reaction?

38. Derive an expression to calculate time required for completion of zero order reaction.

39. For a reaction $A + B \longrightarrow$ Products, the rate law is — Rate = $k\,[A][B]^{3/2}$

Can the reaction be an elementary reaction? Explain.

40. For a certain reaction large fraction of molecules has energy more than the threshold energy, yet the rate of reaction is very slow. Why?

41. For a zero order reaction will the molecularity be equal to zero? Explain.

42. For a general reaction A ⟶ B, plot of concentration of A vs time is given in Fig. 4.3. Answer the following question on the basis of this graph.

(i) What is the order of the reaction?

(ii) What is the slope of the curve?

(iii) What are the units of rate constant?

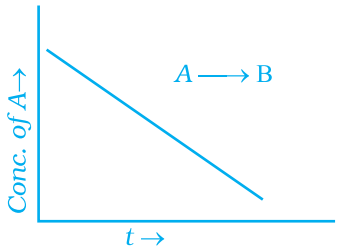


Fig. *4.3*

43. The reaction between $H_2(g)$ and $O_2(g)$ is highly feasible yet allowing the gases to stand at room temperature in the same vessel does not lead to the formation of water. Explain.

44. Why does the rate of a reaction increase with rise in temperature?

45. Oxygen is available in plenty in air yet fuels do not burn by themselves at room temperature. Explain.

46. Why is the probability of reaction with molecularity higher than three very rare?

47. Why does the rate of any reaction generally decreases during the course of the reaction?

48. Thermodynamic feasibility of the reaction alone cannot decide the rate of the reaction. Explain with the help of one example.

49. Why in the redox titration of $KMnO_4$ vs oxalic acid, we heat oxalic acid solution before starting the titration?

50. Why can't molecularity of any reaction be equal to zero?

51. Why molecularity is applicable only for elementary reactions and order is applicable for elementary as well as complex reactions?

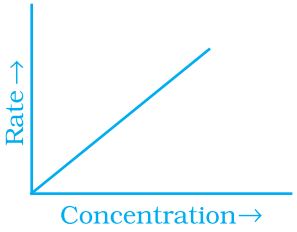
52. Why can we not determine the order of a reaction by taking into consideration the balanced chemical equation?

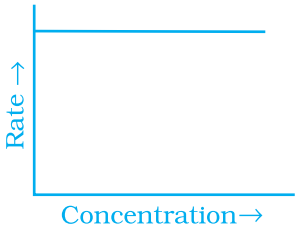
IV. Matching Type

Note : In the following questions match the items of Column I with appropriate item given in Column II.

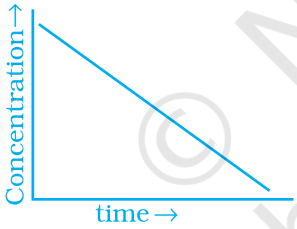
53. Match the graph given in Column I with the order of reaction given in Column II. More than one item in Column I may link to the same item of Column II.

Column I **Column II**

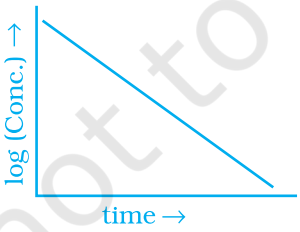
(i) 

(ii) 

(a) Ist order

(iii) 

(b) Zero order

(iv) 

54. Match the statements given in Column I and Column II

Column I	**Column II**
(i) Catalyst alters the rate of reaction	(a) cannot be fraction or zero
(ii) Molecularity	(b) proper orientation is not there always

(iii)	Second half life of first order reaction	(c)	by lowering the activation energy
(iv)	$e^{-E_a/RT}$	(d)	is same as the first
(v)	Energetically favourable reactions are sometimes slow	(e)	total probability is one
(vi)	Area under the Maxwell Boltzman curve is constant	(f)	refers to the fraction of molecules with energy equal to or greater than activation energy

55. Match the items of Column I and Column II.

	Column I		**Column II**
(i)	Diamond	(a)	short interval of time
(ii)	Instantaneous rate	(b)	ordinarily rate of conversion is imperceptible
(iii)	Average rate	(c)	long duration of time

56. Match the items of Column I and Column II.

	Column I		**Column II**
(i)	Mathematical expression for rate of reaction	(a)	rate constant
(ii)	Rate of reaction for zero order reaction is equal to	(b)	rate law
(iii)	Units of rate constant for zero order reaction is same as that of	(c)	order of slowest step
(iv)	Order of a complex reaction is determined by	(d)	rate of a reaction

V. Assertion and Reason Type

Note: In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are correct and the reason is correct explanation of assertion.

(ii) Both assertion and reason are correct but reason does not explain assertion.

(iii) Assertion is correct but reason is incorrect.

(iv) Both assertion and reason are incorrect.

(v) Assertion is incorrect but reason is correct.

57. **Assertion** : Order of the reaction can be zero or fractional.
Reason : We cannot determine order from balanced chemical equation.

58. **Assertion** : Order and molecularity are same.
Reason : Order is determined experimentally and molecularity is the sum of the stoichiometric coefficient of rate determining elementary step.

59. **Assertion** : The enthalpy of reaction remains constant in the presence of a catalyst.
Reason : A catalyst participating in the reaction, forms different activated complex and lowers down the activation energy but the difference in energy of reactant and product remains the same.

60. **Assertion** : All collision of reactant molecules lead to product formation.
Reason : Only those collisions in which molecules have correct orientation and sufficient kinetic energy lead to compound formation.

61. **Assertion** : Rate constants determined from Arrhenius equation are fairly accurate for simple as well as complex molecules.
Reason : Reactant molecules undergo chemical change irrespective of their orientation during collision.

VI. Long Answer Type

62. All energetically effective collisions do not result in a chemical change. Explain with the help of an example.

63. What happens to most probable kinetic energy and the energy of activation with increase in temperature?

64. Describe how does the enthalpy of reaction remain unchanged when a catalyst is used in the reaction.

65. Explain the difference between instantaneous rate of a reaction and average rate of a reaction.

66. With the help of an example explain what is meant by pseudo first order reaction.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)	2. (iii)	3. (ii)	4. (i)	5. (ii)	6. (i)
7. (iv)	8. (iii)	9. (iii)	10. (ii)	11. (i)	12. (iii)
13. (i)	14. (ii)	15. (iii)	16. (iv)	17. (ii)	18. (ii)
19. (ii)	20. (ii)				

II. Multiple Choice Questions (Type-II)

21. (i), (iii), (iv)	22. (i), (iv)	23. (i), (ii)	24. (i), (iv)
25. (i), (iii), (iv)	26. (i), (iv)	27. (i), (iii)	28. (i), (iv)
29. (i), (ii)	30. (ii), (iv)	31. (i), (iv)	32. (i), (iv)

III. Short Answer Type

33. Bimolecular reaction becomes kinetically first order when one of the reactants is in excess.

34. Rate = k $[A]^0[B]^0$ or Rate = k

35. See page no. 99 of NCERT textbook for Class XII.

36. If the reaction is an elementary reaction, order is same as molecularity.

37. Three, because rate = k $[A]^3$

38. $[R] = [R]_0 - kt$

for completion $[R] = 0$

$$\therefore \; t = \frac{[R]_0}{k}$$

39. During an elementary reaction, the number of atoms or ions colliding to react is referred to as molecularity. Had this been an elementary reaction the order of reaction with respect to B would have been 1, but in the given rate law it is $\frac{3}{2}$. This indicates that the reaction is not an elementary reaction.

40. Apart from the energy considerations, the colliding molecules should also have proper orientation for effective collision. This condition might not be getting fulfilled in the reaction.

41. No, the molecularity can never be zero or a fractional number.

42. (i) Zero (ii) $-k$ (iii) mol L^{-1} s^{-1}

43. This is because activation energy for the reaction is very high at room temperature.

44. At higher temperatures, larger fraction of colliding particles can cross the energy barrier (i.e. the activation energy), which leads to faster rate.

45. The activation energy for combustion reactions of fuels is very high at room temperature therefore they do not burn by themselves.

46. The probability of more than three molecules colliding simultaneously is very small. Hence possibility of molecularity being three is very low.

47. The rate of a reaction depends on the concentration of reactants. As the reaction progresses, reactants start getting converted to products so the concentration of reactants decreases hence the rate decreases.

48. Thermodynamically the conversion of diamond to graphite is highly feasible but this reaction is very slow because its activation energy is high.

49. The reaction between $KMnO_4$ and oxalic acid is very slow. By raising the temperature we can enhance the rate of reaction.

50. Molecularity is the number of molecules taking part in an elementary step. For this we require at least a single molecule leading to the value of minimum molecularity of one.

51. A complex reaction proceeds through several elementary reactions. Numbers of molecules involved in each elementary reaction may be different i.e., the molecularity of each step may be different. Therefore, discussion of molecularity of overall complex reaction is meaningless. On the other hand, order of a complex reaction is determined by the slowest step in its mechanism and is not meaningless even in the case of complex reactions.

52. Balanced chemical equation often leads to incorrect order or rate law. For example the following reaction seems to be a tenth order reaction.

$$KClO_3 + 6FeSO_4 + 3H_2SO_4 \longrightarrow KCl + 3H_2O + 3Fe_2(SO_4)_3$$

This is actually a second order reaction. Actually the reaction is complex and occurs in several steps. The order of such reaction is determined by the slowest step in the reaction mechanism. Order is determined experimentally and is confined to the dependence of observed rate of reaction on the concentration of reactants.

IV. Matching Type

53. (i) → (a) (ii) → (b) (iii) → (b) (iv) → (a)

54. (i) → (c) (ii) → (a) (iii) → (d) (iv) → (f)
(v) → (b) (vi) → (e)

55. (i) → (b) (ii) → (a) (iii) → (c)

56. (i) → (b) (ii) → (a) (iii) → (d) (iv) → (d)

V. Assertion and Reason Type

57. (ii) 58. (v) 59. (i) 60. (v) 61. (iii)

VI. Long Answer Type

62. **Hint:** Proper orientation of molecule should be explained in detail.

63. **Hint :**
- Flattening of curve and shifting of maxima towards high energy value.
- Area under the curve beyond the activation energy increases.

64. **Hint :**
- Enthalpy is a state function.
- Difference in energy between reactants and product is constant.

65. See NCERT textbook for Class XII.

66. See NCERT textbook for Class XII.

Unit

5

SURFACE CHEMISTRY

I. Multiple Choice Questions (Type-I)

1. Which of the following process does **not** occur at the interface of phases?

(i) crystallisation

(ii) heterogenous catalysis

(iii) homogeneous catalysis

(iv) corrosion

2. At the equilibrium position in the process of adsorption _____.

(i) $\Delta H > 0$

(ii) $\Delta H = T\Delta S$

(iii) $\Delta H > T\Delta S$

(iv) $\Delta H < T\Delta S$

3. Which of the following interface **cannot** be obtained?

(i) liquid-liquid

(ii) solid-liquid

(iii) liquid-gas

(iv) gas-gas

4. The term 'sorption' stands for _____.

(i) absorption

(ii) adsorption

(iii) both absorption and adsorption

(iv) desorption

5. Extent of physisorption of a gas increases with _____.

(i) increase in temperature.

(ii) decrease in temperature.

(iii) decrease in surface area of adsorbent.

(iv) decrease in strength of van der Waals forces.

6. Extent of adsorption of adsorbate from solution phase increases with _____.

(i) increase in amount of adsorbate in solution.

(ii) decrease in surface area of adsorbent.

(iii) increase in temperature of solution.

(iv) decrease in amount of adsorbate in solution.

7. Which one of the following is **not** applicable to the phenomenon of adsorption?

(i) $\Delta H > 0$

(ii) $\Delta G < 0$

(iii) $\Delta S < 0$

(iv) $\Delta H < 0$

8. Which of the following is **not** a favourable condition for physical adsorption?

(i) high pressure

(ii) negative ΔH

(iii) higher critical temperature of adsorbate

(iv) high temperature

9. Physical adsorption of a gaseous species may change to chemical adsorption with _____.

(i) decrease in temperature

(ii) increase in temperature

(iii) increase in surface area of adsorbent

(iv) decrease in surface area of adsorbent

10. In physisorption adsorbent does not show specificity for any particular gas because _____.

(i) involved van der Waals forces are universal.

(ii) gases involved behave like ideal gases.

(iii) enthalpy of adsorption is low.

(iv) it is a reversible process.

11. Which of the following is an example of absorption?

(i) Water on silica gel

(ii) Water on calcium chloride

(iii) Hydrogen on finely divided nickel

(iv) Oxygen on metal surface

12. On the basis of data given below predict which of the following gases shows least adsorption on a definite amount of charcoal?

Gas	CO_2	SO_2	CH_4	H_2
Critical temp./K	304	630	190	33

(i) CO_2
(ii) SO_2
(iii) CH_4
(iv) H_2

13. In which of the following reactions heterogenous catalysis is involved?

(a) $2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$

(b) $2SO_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$

(c) $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$

(d) $CH_3COOCH_3(l) + H_2O(l) \xrightarrow{HCl(l)} CH_3COOH(aq) + CH_3OH(aq)$

(i) (b), (c)
(ii) (b), (c), (d)
(iii) (a), (b), (c)
(iv) (d)

14. At high concentration of soap in water, soap behaves as _____.

(i) molecular colloid
(ii) associated colloid
(iii) macromolecular colloid
(iv) lyophilic colloid

15. Which of the following will show Tyndall effect?

(i) Aqueous solution of soap below critical micelle concentration.
(ii) Aqueous solution of soap above critical micelle concentration.
(iii) Aqueous solution of sodium chloride.
(iv) Aqueous solution of sugar.

16. Method by which lyophobic sol can be protected.

(i) By addition of oppositely charged sol.
(ii) By addition of an electrolyte.
(iii) By addition of lyophilic sol.
(iv) By boiling.

17. Freshly prepared precipitate sometimes gets converted to colloidal solution by _____.

(i) coagulation
(ii) electrolysis

(iii) diffusion

(iv) peptisation

18. Which of the following electrolytes will have maximum coagulating value for AgI/Ag^+ sol?

(i) Na_2S

(ii) Na_3PO_4

(iii) Na_2SO_4

(iv) NaCl

19. A colloidal system having a solid substance as a dispersed phase and a liquid as a dispersion medium is classified as _____.

(i) solid sol

(ii) gel

(iii) emulsion

(iv) sol

20. The values of colligative properties of colloidal solution are of small order in comparison to those shown by true solutions of same concentration because of colloidal particles _____.

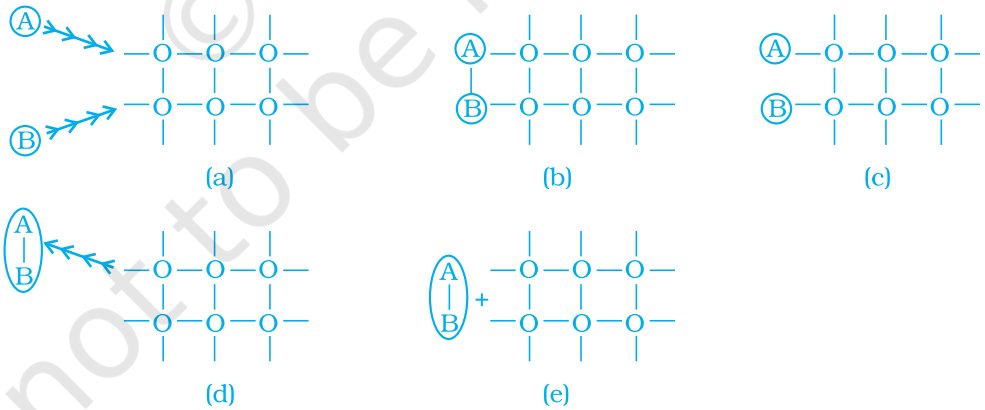
(i) exhibit enormous surface area.

(ii) remain suspended in the dispersion medium.

(iii) form lyophilic colloids.

(iv) are comparatively less in number.

21. Arrange the following diagrams in correct sequence of steps involved in the mechanism of catalysis, in accordance with modern adsorption theory.



(i) a ⟶ b ⟶ c ⟶ d ⟶ e

(ii) a ⟶ c ⟶ b ⟶ d ⟶ e

(iii) a ⟶ c ⟶ b ⟶ e ⟶ d

(iv) a ⟶ b ⟶ c ⟶ e ⟶ d

22. Which of the following process is responsible for the formation of delta at a place where rivers meet the sea?

(i) Emulsification

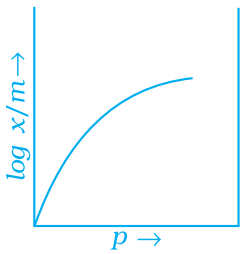
(ii) Colloid formation

(iii) Coagulation

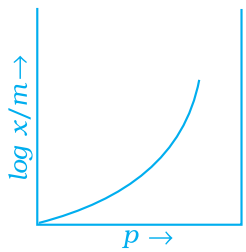
(iv) Peptisation

23. Which of the following curves is in accordance with Freundlich adsorption isotherm?

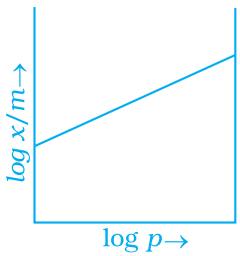
(i)



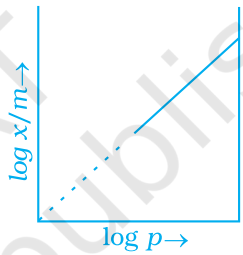
(ii)



(iii)



(iv)



24. Which of the following process is **not** responsible for the presence of electric charge on the sol particles?

(i) Electron capture by sol particles.

(ii) Adsorption of ionic species from solution.

(iii) Formation of Helmholtz electrical double layer.

(iv) Absorption of ionic species from solution.

25. Which of the following phenomenon is applicable to the process shown in the Fig. 5.1?

(i) Absorption

(ii) Adsorption

(iii) Coagulation

(iv) Emulsification

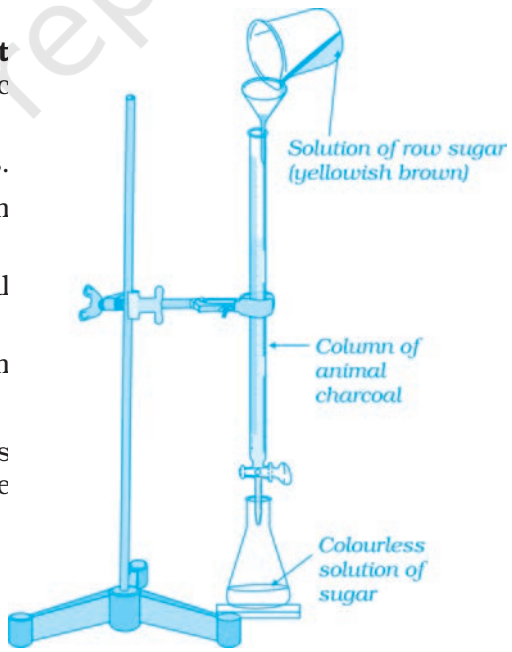


Fig. *5.1*

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

26. Which of the following options are correct?

(i) Micelle formation by soap in aqueous solution is possible at all temperatures.

(ii) Micelle formation by soap in aqueous solution occurs above a particular concentration.

(iii) On dilution of soap solution micelles may revert to individual ions.

(iv) Soap solution behaves as a normal strong electrolyte at all concentrations.

27. Which of the following statements are correct about solid catalyst?

(i) Same reactants may give different product by using different catalysts.

(ii) Catalyst does not change ΔH of reaction.

(iii) Catalyst is required in large quantities to catalyse reactions.

(iv) Catalytic activity of a solid catalyst does not depend upon the strength of chemisorption.

28. Freundlich adsorption isotherm is given by the expression $\frac{x}{m} = k\ p^{\frac{1}{n}}$ which of the following conclusions can be drawn from this expression.

(i) When $\frac{1}{n} = 0$, the adsorption is independent of pressure.

(ii) When $\frac{1}{n} = 0$, the adsorption is directly proportional to pressure.

(iii) When $n = 0$, $\frac{x}{m}$ vs p graph is a line parallel to x-axis.

(iv) When $n = 0$, plot of $\frac{x}{m}$ vs p is a curve.

29. H_2 gas is adsorbed on activated charcoal to a very little extent in comparison to easily liquefiable gases due to _____.

(i) very strong van der Waal's interaction.

(ii) very weak van der Waals forces.

(iii) very low critical temperature.

(iv) very high critical temperature.

30. Which of the following statements are correct?

(i) Mixing two oppositely charged sols neutralises their charges and stabilises the colloid.

(ii) Presence of equal and similar charges on colloidal particles provides stability to the colloids.

(iii) Any amount of dispersed liquid can be added to emulsion without destabilising it.

(iv) Brownian movement stabilises sols.

31. An emulsion cannot be broken by _____ and _____.

(i) heating

(ii) adding more amount of dispersion medium

(iii) freezing

(iv) adding emulsifying agent

32. Which of the following substances will precipitate the negatively charged emulsions?

(i) KCl

(ii) glucose

(iii) urea

(iv) NaCl

33. Which of the following colloids **cannot** be coagulated easily?

(i) Lyophobic colloids.

(ii) Irreversible colloids.

(iii) Reversible colloids.

(iv) Lyophilic colloids.

34. What happens when a lyophilic sol is added to a lyophobic sol?

(i) Lyophobic sol is protected.

(ii) Lyophilic sol is protected.

(iii) Film of lyophilic sol is formed over lyophobic sol.

(iv) Film of lyophobic sol is formed over lyophilic sol.

35. Which phenomenon occurs when an electric field is applied to a colloidal solution and electrophoresis is prevented?

(i) Reverse osmosis takes place.

(ii) Electroosmosis takes place.

(iii) Dispersion medium begins to move.

(iv) Dispersion medium becomes stationary.

36. In a reaction, catalyst changes _____.

(i) physically

(ii) qualitatively

(iii) chemically

(iv) quantitatively

37. Which of the following phenomenon occurs when a chalk stick is dipped in ink?

(i) adsorption of coloured substance

(ii) adsorption of solvent

(iii) absorption and adsorption both of solvent

(iv) absoprtion of solvent

III. Short Answer Type

38. Why is it important to have clean surface in surface studies?

39. Why is chemisorption referred to as activated adsorption?

40. What type of solutions are formed on dissolving different concentrations of soap in water?

41. What happens when gelatin is mixed with gold sol?

42. How does it become possible to cause artificial rain by spraying silver iodide on the clouds?

43. Gelatin which is a peptide is added in icecreams. What can be its role?

44. What is collodion?

45. Why do we add alum to purify water?

46. What happens when electric field is applied to colloidal solution?

47. What causes brownian motion in colloidal dispersion?

48. A colloid is formed by adding $FeCl_3$ in excess of hot water. What will happen if excess sodium chloride is added to this colloid?

49. How do emulsifying agents stabilise the emulsion?

50. Why are some medicines more effective in the colloidal form?

51. Why does leather get hardened after tanning?

52. How does the precipitation of colloidal smoke take place in Cottrell precipitator?

53. How will you distinguish between dispersed phase and dispersion medium in an emulsion?

54. On the basis of Hardy-Schulze rule explain why the coagulating power of phosphate is higher than chloride.

55. Why does bleeding stop by rubbing moist alum?

56. Why is $Fe(OH)_3$ colloid positively charged, when prepared by adding $FeCl_3$ to hot water?

57. Why do physisorption and chemisorption behave differently with rise in temperature?

58. What happens when dialysis is prolonged?

59. Why does the white precipitate of silver halide become coloured in the presence of dye eosin.

60. What is the role of activated charcoal in gas mask used in coal mines?

61. How does a delta form at the meeting place of sea and river water?

62. Give an example where physisorption changes to chemisorption with rise in temperature. Explain the reason for change.

63. Why is desorption important for a substance to act as good catalyst?

64. What is the role of diffusion in heterogenous catalysis?

65. How does a solid catalyst enhance the rate of combination of gaseous molecules?

66. Do the vital functions of the body such as digestion get affected during fever? Explain your answer.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

67. Method of formation of solution is given in Column I. Match it with the type of solution given in Column II.

	Column I		**Column II**
(i)	Sulphur vapours passed through cold water	(a)	Normal electrolyte solution
(ii)	Soap mixed with water above critical micelle concentration	(b)	Molecular colloids
(iii)	White of egg whipped with water	(c)	Associated colloid
(iv)	Soap mixed with water below critical micelle concentration	(d)	Macro molecular colloids

68. Match the statement given in Column I with the phenomenon given in Column II.

	Column I		**Column II**
(i)	Dispersion medium moves in an electric field	(a)	Osmosis
(ii)	Solvent molecules pass through semi permeable membrane towards solvent side	(b)	Electrophoresis
(iii)	Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes	(c)	Electroosmosis
(iv)	Solvent molecules pass through semi permeable membranes towards solution side	(d)	Reverse osmosis

69. Match the items given in Column I and Column II.

	Column I		Column II
(i)	Protective colloid	(a)	$FeCl_3$ + NaOH
(ii)	Liquid - liquid colloid	(b)	Lyophilic colloids
(iii)	Positively charged colloid	(c)	Emulsion
(iv)	Negatively charged colloid	(d)	$FeCl_3$ + hot water

70. Match the types of colloidal systems given in Column I with the name given in Column II.

	Column I		Column II
(i)	Solid in liquid	(a)	Foam
(ii)	Liquid in solid	(b)	Sol
(iii)	Liquid in liquid	(c)	Gel
(iv)	Gas in liquid	(d)	Emulsion

71. Match the items of Column I and Column II.

	Column I		Column II
(i)	Dialysis	(a)	Cleansing action of soap
(ii)	Peptisation	(b)	Coagulation
(iii)	Emulsification	(c)	Colloidal sol formation
(iv)	Electrophoresis	(d)	Purification

72. Match the items of Column I and Column II.

	Column I		Column II
(i)	Butter	(a)	dispersion of liquid in liquid
(ii)	Pumice stone	(b)	dispersion of solid in liquid
(iii)	Milk	(c)	dispersion of gas in solid
(iv)	Paints	(d)	dispersion of liquid in solid

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct and the reason is correct explanation of assertion.

(ii) Assertion and reason both are correct but reason does not explain assertion.

(iii) Assertion is correct but reason is incorrect.

(iv) Both assertion and reason are incorrect.

(v) Assertion is incorrect but reason is correct.

73. **Assertion** : An ordinary filter paper impregnated with collodion solution stops the flow of colloidal particles.

Reason : Pore size of the filter paper becomes more than the size of colloidal particle.

74. **Assertion** : Colloidal solutions show colligative properties.

Reason : Colloidal particles are large in size.

75. **Assertion** : Colloidal solutions do not show brownian motion.

Reason : Brownian motion is responsible for stability of sols.

76. **Assertion** : Coagulation power of Al^{3+} is more than Na^{+}.

Reason : Greater the valency of the flocculating ion added, greater is its power to cause precipitation (Hardy Schulze rule).

77. **Assertion** : Detergents with low CMC are more economical to use.

Reason : Cleansing action of detergents involves the formation of micelles. These are formed when the concentration of detergents becomes equal to CMC.

VI. Long Answer Type

78. What is the role of adsorption in heterogenous catalysis?

79. What are the applications of adsorption in chemical analysis?

80. What is the role of adsorption in froth floatation process used especially for concentration of sulphide ores?

81. What do you understand by shape selective catalysis? Why are zeolites good shape selective catalysts?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)	2. (ii)	3. (iv)	4. (iii)	5. (ii)	6. (i)
7. (i)	8. (iv)	9. (ii)	10. (i)	11. (ii)	12. (iv)
13. (i)	14. (ii)	15. (ii)	16. (iii)	17. (iv)	18. (ii)
19. (iv)	20. (iv)	21. (ii)	22. (iii)	23. (iii)	24. (iv)
25. (ii)					

II. Multiple Choice Questions (Type-II)

26. (ii), (iii)	27. (i), (ii)	28. (i), (iii)	29. (ii), (iii)
30. (ii), (iv)	31. (ii), (iv)	32. (i), (iv)	33. (iii), (iv)
34. (i), (iii)	35. (ii), (iii)	36. (i), (ii)	37. (i), (iv)

III. Short Answer Type

38. It is important to have clean surface as it facilitates the adsorption of desired species.
39. Chemisorption involves formation of bond between gaseous molecules/ atoms and the solid surface for which high activation energy is required. Thus it is referred to as activated adsorption.
40. At lower concentration soap forms a normal electrolytic solution with water. After a certain concentration called critical micelle concentration, colloidal solution is formed.
41. Gold sol is a lyophobic sol. Addition of gelatin stabilises the sol.
42. Clouds are colloidal in nature and carry charge. Spray of silver iodide, an electrolyte, results in coagulation leading to rain.
43. Icecreams are emulsions which get stabilised by emulsifying agents like gelatin.
44. It is a 4% solution of nitrocellulose in a mixture of alcohol and ether.
45. The colloidal impurities present in water get coagulated by added alum, thus making water potable.
46. The charged colloidal particles start moving towards oppositely charged electrodes.
47. Unbalanced bombardment of the particles of dispersed phase by molecules of dispersion medium causes brownian motion. This stabilises the sol.
48. Positively charged sol of hydrated ferric oxide is formed and on adding excess of NaCl, negatively charged chloride ions coagulate the positively charged sol of hydrated ferric oxide.

49. The emulsifying agent forms an interfacial layer between suspended particles and the dispersion medium thereby stabilising the emulsion.

50. Medicines are more effective in the colloidal form because of large surface area and are easily assimilated in this form.

51. Animal hide is colloidal in nature and has positively charged particles. When it is soaked in tanin which has negatively charged colloidal particles, it results in mutual coagulation taking place.

52. In Cottrell precipitator, charged smoke particles are passed through a chamber containing plates with charge opposite to the smoke particles. Smoke particles lose their charge on the plates and get precipitated.

53. On adding dispersion medium, emulsions can be diluted to any extent. The dispersed phase forms a separate layer if added in excess.

54. Minimum quantity of an electrolyte required to cause precipitation of a sol is called its coagulating value. Greater the charge on flocculating ion and smaller is the amount of electrolyte required for precipitation, higher is the coagulating power of coagulating ion (Hardy-Schulze rule).

55. Moist alum coagulates the blood and so formed blood clot stops bleeding.

56. The adsorption of positively charged Fe^{3+} ions by the sol of hydrated ferric oxide results in positively charged colloid.

57. Physisorption involves weak van der Waals forces which weaken with rise in temperature. The chemisorption involves formation of chemical bond involving activation energy and like any other chemical reaction is favoured by rise in temperature.

58. Due to excessive dialysis, traces of electrolyte which stabilises the colloids is removed completely, making the colloid unstable. As a result coagulation takes place.

59. Eosin is adsorbed on the surface of silver halide precipitate making it coloured.

60. Activated charcoal acts as an adsorbent for various poisonous gases present in the coal mines.

61. River water is a colloidal solution of clay and sea water contains lot of electrolytes. The point at which river and sea meet is the site for coagulation. Deposition of coagulated clay results in delta formation.

62. The process of physisorption for example that of H_2 on finely divided nickel, involves weak van der Waals' forces. With increase in temperature, hydrogen molecules dissociate into hydrogen atoms which are held on the surface by chemisorption.

63. After the reaction is over between adsorbed reactants, the process of desorption is important to remove products and further create space for the other reactant molecules to approach the surface and react.

64. The gaseous molecules diffuse on to the surface of the solid catalyst and get adsorbed. After the required chemical changes the products diffuse away from the surface of the catalyst leaving the surface free for more reactant molecules to get adsorbed and undergo reaction.

65. When gaseous molecules come in contact with the surface of a solid catalyst, a weak chemical combination takes place between the surface of the catalyst and the gaseous molecules, which increases the concentration of reactants on the surface. Different moelcules adsorbed side by side have better chance to react and form new molecules. This enhances the rate of reaction. Also, adsorption is an exothermic process. The heat released in the process of adsorption is utilised in enhancing the reaction rate.

66. **Hint :** The optimum temperature range for enzymatic activity is 298-310 K. On either side of this temperature range, enzymatic activity gets affected. Thus, during fever, when temperature rises above 310 K, the activity of enzymes may be affected.

IV. Matching Type

67.	(i) → (b)	(ii) → (c)	(iii) → (d)	(iv) → (a)
68.	(i) → (c)	(ii) → (d)	(iii) → (b)	(iv) → (a)
69.	(i) → (b)	(ii) → (c)	(iii) → (d)	(iv) → (a)
70.	(i) → (b)	(ii) → (c)	(iii) → (d)	(iv) → (a)
71.	(i) → (d)	(ii) → (c)	(iii) → (a)	(iv) → (b)
72.	(i) → (d)	(ii) → (c)	(iii) → (a)	(iv) → (b)

V. Assertion and Reason Type

73. (iii) 74. (ii) 75. (v) 76. (i) 77. (i)

VI. Long Answer Type

78. **Hint**
- reactants are adsorbed on the surface of the catalyst
- occurrence of chemical reaction on the surface of catalyst
- desorption.

79. **Hint:**
- In TLC
- Adsorption indicators.
- In qualitative analysis.

80. **Hint:**
- Adsorption of pine oil on sulphide ore particles.
- Formation of emulsion.
- Hence ore comes out with froth.
- Explanation for shape selective catalysis.

81. **Hint:**
- Honey comb like structure of zeolites.
- Pores provide sites for reactants to react.

Unit

6

GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

I. Multiple Choice Questions (Type-I)

1. In the extraction of chlorine by electrolysis of brine _____.

(i) oxidation of Cl^- ion to chlorine gas occurs.

(ii) reduction of Cl^- ion to chlorine gas occurs.

(iii) For overall reaction $\Delta G^\ominus$ has negative value.

(iv) a displacement reaction takes place.

2. When copper ore is mixed with silica, in a reverberatory furnace copper matte is produced. The copper matte contains _____.

(i) sulphides of copper (II) and iron (II)

(ii) sulphides of copper (II) and iron (III)

(iii) sulphides of copper (I) and iron (II)

(iv) sulphides of copper (I) and iron (III)

3. Which of the following reactions is an example of autoreduction?

(i) $Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$

(ii) $Cu_2O + C \longrightarrow 2Cu + CO$

(iii) $Cu^{2+}(aq) + Fe(s) \longrightarrow Cu(s) + Fe^{2+}(aq)$

(iv) $Cu_2O + \frac{1}{2}Cu_2S \longrightarrow 3Cu + \frac{1}{2}SO_2$

4. A number of elements are available in earth's crust but most abundant elements are _____.

(i) Al and Fe

(ii) Al and Cu

(iii) Fe and Cu

(iv) Cu and Ag

5. Zone refining is based on the principle that _____.

(i) impurities of low boiling metals can be separated by distillation.

(ii) impurities are more soluble in molten metal than in solid metal.

(iii) different components of a mixture are differently adsorbed on an adosrbent.

(iv) vapours of volatile compound can be decomposed in pure metal.

6. In the extraction of copper from its sulphide ore, the metal is formed by the reduction of Cu_2O with

(i) FeS

(ii) CO

(iii) Cu_2S

(iv) SO_2

7. Brine is electrolysed by using inert electrodes. The reaction at anode is _____.

(i) $Cl^-(aq.) \longrightarrow \frac{1}{2} Cl_2(g) + e^-$; $E^{\ominus}_{Cell} = 1.36V$

(ii) $2H_2O(l) \longrightarrow O_2(g) + 4H^+ + 4e^-$; $E^{\ominus}_{Cell} = 1.23V$

(iii) $Na^+(aq.) + e^- \longrightarrow Na(s)$; $E^{\ominus}_{Cell} = 2.71V$

(iv) $H^+(aq.) + e^- \longrightarrow \frac{1}{2} H_2(g)$; $E^{\ominus}_{Cell} = 0.00V$

8. In the metallurgy of aluminium _____.

(i) Al^{3+} is oxidised to Al (s).

(ii) graphide anode is oxidised to carbon monoxide and carbon dioxide.

(iii) oxidation state of oxygen changes in the reaction at anode.

(iv) oxidation state of oxygen changes in the overall reaction involved in the process.

9. Electrolytic refining is used to purify which of the following metals?

(i) Cu and Zn

(ii) Ge and Si

(iii) Zr and Ti

(iv) Zn and Hg

10. Extraction of gold and silver involves leaching the metal with CN^- ion. The metal is recovered by _____.

(i) displacement of metal by some other metal from the complex ion.

(ii) roasting of metal complex.

(iii) calcination followed by roasting.

(iv) thermal decomposition of metal complex.

Note : Answer the questions 11-13 on the basis of Fig. 6.1.

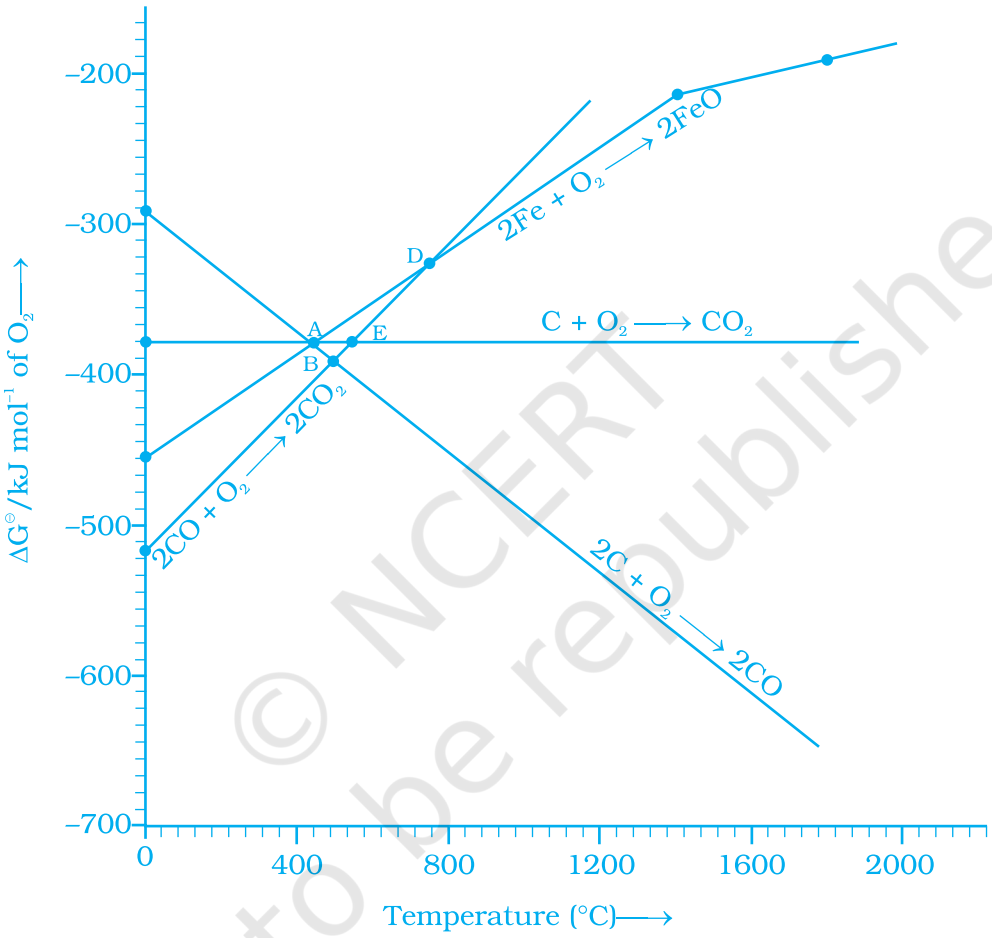


Fig. 6.1

11. Choose the correct option of temperature at which carbon reduces FeO to iron and produces CO.

(i) Below temperature at point A.

(ii) Approximately at the temperature corresponding to point A.

(iii) Above temperature at point A but below temperature at point D.

(iv) Above temperature at point A.

12. Below point 'A' FeO can _____.

(i) be reduced by carbon monoxide only.

(ii) be reduced by both carbon monoxide and carbon.

(iii) be reduced by carbon only.

(iv) not be reduced by both carbon and carbon monoxide.

13. For the reduction of FeO at the temperature corresponding to point D, which of the following statements is correct?

(i) ΔG value for the overall reduction reaction with carbon monoxide is zero.

(ii) ΔG value for the overall reduction reaction with a mixture of 1 mol carbon and 1 mol oxygen is positive.

(iii) ΔG value for the overall reduction reaction with a mixture of 2 mol carbon and 1 mol oxygen will be positive.

(iv) ΔG value for the overall reduction reaction with carbon monoxide is negative.

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

14. At the temperature corresponding to which of the points in Fig.6.1, FeO will be reduced to Fe by coupling the reaction $2FeO \longrightarrow 2Fe + O_2$ with all of the following reactions?

(a) $C + O_2 \longrightarrow CO_2$ (b) $2C + O_2 \longrightarrow 2CO$ and (c) $2CO + O_2 \longrightarrow 2\ CO_2$

(i) Point A

(ii) Point B

(iii) Point D

(iv) Point E

15. Which of the following options are correct?

(i) Cast iron is obtained by remelting pig iron with scrap iron and coke using hot air blast.

(ii) In extraction of silver, silver is extracted as cationic complex.

(iii) Nickel is purified by zone refining.

(iv) Zr and Ti are purified by van Arkel method.

16. In the extraction of aluminium by Hall-Heroult process, purified Al_2O_3 is mixed with CaF_2 to

(i) lower the melting point of Al_2O_3.

(ii) increase the conductivity of molten mixture.

(iii) reduce Al^{3+} into Al(s).

(iv) acts as catalyst.

17. Which of the following statements is correct about the role of substances added in the froth floation process?

(i) Collectors enhance the non-wettability of the mineral particles.

(ii) Collectors enhance the wettability of gangue particles.

(iii) By using depressants in the process two sulphide ores can be separated.

(iv) Froth stabilisers decrease wettability of gangue.

18. In the Froth Floatation process, zinc sulphide and lead sulphide can be separated by _____.

(i) using collectors.

(ii) adjusting the proportion of oil to water.

(iii) using depressant.

(iv) using froth stabilisers.

19. Common impurities present in bauxite are _____.

(i) CuO

(ii) ZnO

(iii) Fe_2O_3

(iv) SiO_2

20. Which of the following ores are concentrated by froth floation?

(i) Haematite

(ii) Galena

(iii) Copper pyrites

(iv) Magnetite

21. Which of the following reactions occur during calcination?

(i) $CaCO_3 \longrightarrow CaO + CO_2$

(ii) $2FeS_2 + \frac{11}{2} O_2 \longrightarrow Fe_2O_3 + 4SO_2$

(iii) $Al_2O_3.x\,H_2O \longrightarrow Al_2O_3 + x\,H_2O$

(iv) $ZnS + \frac{3}{2} O_2 \longrightarrow ZnO + SO_2$

22. For the metallurgical process of which of the ores calcined ore can be reduced by carbon?

(i) haematite

(ii) calamine

(iii) iron pyrites

(iv) sphalerite

23. The main reactions occurring in blast furnace during extraction of iron from haematite are _____.

(i) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

(ii) $FeO + SiO_2 \longrightarrow FeSiO_3$

(iii) $Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

(iv) $CaO + SiO_2 \longrightarrow CaSiO_3$

24. In which of the following method of purification, metal is converted to its volatile compound which is decomposed to give pure metal?

(i) heating with stream of carbon monoxide.

(ii) heating with iodine.

(iii) liquation.

(iv) distillation.

25. Which of the following statements are correct?

(i) A depressant prevents certain type of particle to come to the froth.

(ii) Copper matte contains Cu_2S and ZnS.

(iii) The solidified copper obtained from reverberatory furnace has blistered appearance due to evolution of SO_2 during the extraction.

(iv) Zinc can be extracted by self-reduction.

26. In the extraction of chlorine from brine _____.

(i) $\Delta G^{\ominus}$ for the overall reaction is negative.

(ii) $\Delta G^{\ominus}$ for the overall reaction is positive.

(iii) $E^{\ominus}$ for overall reaction has negative value.

(iv) $E^{\ominus}$ for overall reaction has positive value.

III. Short Answer Type

27. Why is an external emf of more than 2.2V required for the extraction of Cl_2 from brine?

28. At temperatures above 1073K coke can be used to reduce FeO to Fe. How can you justify this reduction with Ellingham diagram?

29. Wrought iron is the purest form of iron. Write a reaction used for the preparation of wrought iron from cast iron. How can the impurities of sulphur, silicon and phosphorus be removed from cast iron?

30. How is copper extracted from low grade copper ores?

31. Write two basic requirements for refining of a metal by Mond process and by Van Arkel Method.

32. Although carbon and hydrogen are better reducing agents but they are not used to reduce metallic oxides at high temperatures. Why?

33. How do we separate two sulphide ores by Froth Floatation Method? Explain with an example.

34. The purest form of iron is prepared by oxidising impurities from cast iron in a reverberatory furnace. Which iron ore is used to line the furnace? Explain by giving reaction.

35. The mixture of compounds A and B is passed through a column of Al_2O_3 by using alcohol as eluant. Compound A is eluted in preference to compound B. Which of the compounds A or B, is more readily adsorbed on the column?

36. Why is sulphide ore of copper heated in a furnace after mixing with silica?

37. Why are sulphide ores converted to oxide before reduction?

38. Which method is used for refining Zr and Ti? Explain with equation.

39. What should be the considerations during the extraction of metals by electrochemical method?

40. What is the role of flux in metallurgical processes?

41. How are metals used as semiconductors refined? What is the principle of the method used?

42. Write down the reactions taking place in Blast furnace related to the metallurgy of iron in the temperature range 500-800 K.

43. Give two requirements for vapour phase refining.

44. Write the chemical reactions involved in the extraction of gold by cyanide process. Also give the role of zinc in the extraction.

IV. Matching Type

Note : Match the items given in Column I and Column II in the following questions.

45. Match the items of Column I with items of Column II and assign the correct code:

Column I	**Column II**
(A) Pendulum	(1) Chrome steel
(B) Malachite	(2) Nickel steel
(C) Calamine	(3) Na_3AlF_6
(D) Cryolite	(4) $CuCO_3.Cu(OH)_2$
	(5) $ZnCO_3$

Code :

(i)	A (1)	B (2)	C (3)	D (4)
(ii)	A (2)	B (4)	C (5)	D (3)
(iii)	A (2)	B (3)	C (4)	D (5)
(iv)	A (4)	B (5)	C (3)	D (2)

46. Match the items of Column I with the items of Column II and assign the correct code :

Column I	**Column II**
(A) Coloured bands	(1) Zone refining
(B) Impure metal to volatile complex	(2) Fractional distillation
(C) Purification of Ge and Si	(3) Mond Process
(D) Purification of mercury	(4) Chromatography
	(5) Liquation

Code :

(i)	A (1)	B (2)	C (4)	D (5)
(ii)	A (4)	B (3)	C (1)	D (2)
(iii)	A (3)	B (4)	C (2)	D (1)
(iv)	A (5)	B (4)	C (3)	D (2)

47. Match items of Column I with the items of Column II and assign the correct code :

Column I	**Column II**
(A) Cyanide process	(1) Ultrapure Ge
(B) Froth Floatation Process	(2) Dressing of ZnS
(C) Electrolytic reduction	(3) Extraction of Al
(D) Zone refining	(4) Extraction of Au
	(5) Purification of Ni

Code :

(i)	A (4)	B (2)	C (3)	D (1)
(ii)	A (2)	B (3)	C (1)	D (5)
(iii)	A (1)	B (2)	C (3)	D (4)
(iv)	A (3)	B (4)	C (5)	D (1)

48. Match the items of Column I with the items of Column II and assign the correct code :

Column I	**Column II**
(A) Sapphire	(1) Al_2O_3
(B) Sphalerite	(2) NaCN
(C) Depressant	(3) Co
(D) Corundum	(4) ZnS
	(5) Fe_2O_3

Code :

(i)	A (3)	B (4)	C (2)	D (1)
(ii)	A (5)	B (4)	C (3)	D (2)
(iii)	A (2)	B (3)	C (4)	D (5)
(iv)	A (1)	B (2)	C (3)	D (4)

49. Match the items of Column I with items of Column II and assign the correct code :

Column I	**Column II**
(A) Blisterred Cu	(1) Aluminium
(B) Blast furnace	(2) $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$
(C) Reverberatory furnace	(3) Iron
(D) Hall-Heroult process	(4) $FeO + SiO_2 \longrightarrow FeSiO_3$
	(5) $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$

Code :

(i)	A (2)	B (3)	C (4)	D (1)
(ii)	A (1)	B (2)	C (3)	D (5)
(iii)	A (5)	B (4)	C (3)	D (2)
(iv)	A (4)	B (5)	C (3)	D (2)

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are true and reason is the correct explanation of assertion.

(ii) Both assertion and reason are true but reason is not the correct explanation of assertion.

(iii) Assertion is true but reason is false.

(iv) Assertion is false but reason is true.

(v) Assertion and reason both are wrong.

50. **Assertion** : Nickel can be purified by Mond process.

Reason : $Ni(CO)_4$ is a volatile compound which decomposes at 460K to give pure Ni.

51. **Assertion** : Zirconium can be purificed by Van Arkel method.

Reason : ZrI_4 is volatile and decomposes at 1800K.

52. **Assertion** : Sulphide ores are concentrated by Froth Flotation method.
Reason : Cresols stabilise the froth in Froth Flotation method.

53. **Assertion** : Zone refining method is very useful for producing semiconductors.
Reason : Semiconductors are of high purity.

54. **Assertion** : Hydrometallurgy involves dissolving the ore in a suitable reagent followed by precipitation by a more electropositive metal.
Reason : Copper is extracted by hydrometallurgy.

VI. Long Answer Type

55. Explain the following :

(a) CO_2 is a better reducing agent below 710K whereas CO is a better reducing agent above 710K.

(b) Generally sulphide ores are converted into oxides before reduction.

(c) Silica is added to the sulphide ore of copper in the reverberatory furnace.

(d) Carbon and hydrogen are not used as reducing agents at high temperatures.

(e) Vapour phase refining method is used for the purification of Ti.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)	2. (iii)	3. (iv)	4. (i)	5. (ii)	6. (iii)
7. (i)	8. (ii)	9. (i)	10. (i)	11. (iv)	12. (i)
13. (i)					

II. Multiple Choice Questions (Type-II)

14. (ii), (iv)	15. (i), (iv)	16. (i), (ii)	17. (i), (iii)
18. (ii), (iii)	19. (iii), (iv)	20. (ii), (iii)	21. (i), (iii)
22. (i), (ii)	23. (i), (iv)	24. (i), (ii)	25. (i), (iii)
26. (ii), (iii)			

III. Short Answer Type

27. For the reaction

$$2Cl^-(aq) + 2H_2O\ (l) \longrightarrow 2OH^-(aq) + H_2(g) + Cl_2\ (g)$$

Value of $\Delta G^\ominus$ is + 422kJ. Using the equation $\Delta G^\ominus = -nFE^\ominus$ the value of $E^\ominus$ comes out to be –2.2V. Therefore extraction of Cl_2 from brine will require an external emf of greater than 2.2*V*.

28. As per Ellingham diagram at temperatures greater than 1073 K

ΔG (C, CO) < ΔG (Fe, FeO). Hence coke can reduce FeO to Fe.

29. $Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

Limestone is added as flux and sulphur, silicon and phosphorus change to their oxides and pass into the slag.

30. Copper is extracted by hydrometallurgy from low grade copper ores. It is leached out using acid or bacteria. The solution containing Cu^{2+} is treated with scrap iron, Zn or H_2.

$$Cu^{2+}(aq) + H_2(g) \longrightarrow Cu(s) + 2H^+(aq)$$

$$Cu^{2+} + Fe(s) \longrightarrow Fe^{2+}(aq) + Cu(s)$$

31. Basic requirements for both processes are :
   (i) The metal should form a volatile compound with an available reagent.
   (ii) The volatile compound should be easily decomposable, so that recovery of metal is easy.

32. It is because at high temperature carbon and hydrogen react with metals to form carbides and hydrides respectively.

33. Two sulphide ores can be separated by adjusting proportion of oil to water or by using depressants. For example, in the case of an ore containing ZnS and PbS, the depressant NaCN is used. It forms complex with ZnS and prevents it from coming with froth but PbS remains with froth.

34. Haematite

$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

35. Since compound 'A' comes out before compound 'B', the compound 'B' is more readily adsorbed on column.

36. Iron oxide present as impurity in sulphide ore of copper forms slag which is iron silicate and copper is produced in the form of copper matte.

$FeO + SiO_2 \longrightarrow FeSiO_3$

37. Sulphides are not reduced easily but oxides are easily reduced.

38. van Arkel method is used for refining Zr and Ti. In this method crude metal is heated with iodine.

$Zr + 2I_2 \longrightarrow ZrI_4$

$ZrI_4 \xrightarrow{1800K} Zr + 2I_2$

39. Generally two things are considered so that proper precautions can be taken.

(i) reactivity of metal produced.

(ii) suitability of electrodes.

40. Flux is used for making the molten mass more conducting.

41. Semiconducting metal is produced by zone refining method which is based on the principle that the impurities are more soluble in melt than in the solid state of metals.

42. $3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$

$Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$

$Fe_2O_3 + CO \longrightarrow 2FeO + CO_2$

43. (i) The metal should form a volatile compound with available reagent.

(ii) The volatile compound should be easily decomposable so that the recovery is easy.

44. $4Au\ (s) + 8CN^-(aq) + 2H_2O\ (aq) + O_2\ (g) \longrightarrow 4\ [Au\ (CN)_2]^-\ (aq) + 4OH^-\ (aq)$

$2[Au(CN)_2]^-\ (aq) + Zn(s) \longrightarrow 2Au(s) + [Zn\ (CN)_4]^{2-}\ (aq)$

In this reaction zinc acts as a reducing agent.

IV. Matching Type

45. (ii) 46. (ii) 47. (i) 48. (i) 49. (i)

V. Assertion and Reason Type

50. (i) 51. (i) 52. (ii) 53. (ii) 54. (ii)

VI. Long Answer Type

55. (a) **Hint :** Use Ellingham diagram

(b) **Hint :** Oxides are easier to reduce. See Ellingham diagram.

(c) **Hint :** Sulphide ore of copper contains iron as impurity which is removed as iron silicate (slag)

$$FeO + SiO_2 \longrightarrow \underset{\text{(Slag)}}{FeSiO_3}$$

(d) **Hint :** Carbon and hydrogen react with metals at high temperature to form carbides and hydrides respectively.

(e) **Hint :** Ti reacts with iodine to form volatile TiI_4 which decomposes at high temperature to give extra pure titanium.

Unit

7

The p-Block Elements

I. Multiple Choice Questions (Type-I)

1. On addition of conc. H_2SO_4 to a chloride salt, colourless fumes are evolved but in case of iodide salt, violet fumes come out. This is because

(i) H_2SO_4 reduces HI to I_2

(ii) HI is of violet colour

(iii) HI gets oxidised to I_2

(iv) HI changes to HIO_3

2. In qualitative analysis when H_2S is passed through an aqueous solution of salt acidified with dil. HCl, a black precipitate is obtained. On boiling the precipitate with dil. HNO_3, it forms a solution of blue colour. Addition of excess of aqueous solution of ammonia to this solution gives _____.

(i) deep blue precipitate of $Cu(OH)_2$

(ii) deep blue solution of $[Cu(NH_3)_4]^{2+}$

(iii) deep blue solution of $Cu(NO_3)_2$

(iv) deep blue solution of $Cu(OH)_2.Cu(NO_3)_2$

3. In a cyclotrimetaphosphoric acid molecule, how many single and double bonds are present?

(i) 3 double bonds; 9 single bonds

(ii) 6 double bonds; 6 single bonds

(iii) 3 double bonds; 12 single bonds

(iv) Zero double bonds; 12 single bonds

4. Which of the following elements can be involved in pπ–dπ bonding?

(i) Carbon

(ii) Nitrogen

(iii) Phosphorus

(iv) Boron

5. Which of the following pairs of ions are isoelectronic and isostructural?

(i) CO_3^{2-}, NO_3^-

(ii) ClO_3^-, CO_3^{2-}

(iii) SO_3^{2-}, NO_3^-

(iv) ClO_3^-, SO_3^{2-}

6. Affinity for hydrogen decreases in the group from fluorine to iodine. Which of the halogen acids should have highest bond dissociation enthalpy?

(i) HF

(ii) HCl

(iii) HBr

(iv) HI

7. Bond dissociation enthalpy of E—H (E = element) bonds is given below. Which of the compounds will act as strongest reducing agent?

Compound	**NH_3**	**PH_3**	**AsH_3**	**SbH_3**
Δ_{diss} (E—H)/kJ mol^{-1}	389	322	297	255

(i) NH_3

(ii) PH_3

(iii) AsH_3

(iv) SbH_3

8. On heating with concentrated NaOH solution in an inert atmosphere of CO_2, white phosphorus gives a gas. Which of the following statement is **incorrect** about the gas?

(i) It is highly poisonous and has smell like rotten fish.

(ii) It's solution in water decomposes in the presence of light.

(iii) It is more basic than NH_3.

(iv) It is less basic than NH_3.

9. Which of the following acids forms three series of salts?

(i) H_3PO_2

(ii) H_3BO_3

(iii) H_3PO_4

(iv) H_3PO_3

10. Strong reducing behaviour of H_3PO_2 is due to

(i) Low oxidation state of phosphorus

(ii) Presence of two –OH groups and one P–H bond

(iii) Presence of one –OH group and two P–H bonds

(iv) High electron gain enthalpy of phosphorus

11. On heating lead nitrate forms oxides of nitrogen and lead. The oxides formed are _____.

(i) N_2O, PbO

(ii) NO_2, PbO

(iii) NO, PbO

(iv) NO, PbO_2

12. Which of the following elements does not show allotropy?

(i) Nitrogen

(ii) Bismuth

(iii) Antimony

(iv) Arsenic

13. Maximum covalency of nitrogen is _____.

(i) 3

(ii) 5

(iii) 4

(iv) 6

14. Which of the following statements is wrong?

(i) Single N–N bond is stronger than the single P–P bond.

(ii) PH_3 can act as a ligand in the formation of coordination compound with transition elements.

(iii) NO_2 is paramagnetic in nature.

(iv) Covalency of nitrogen in N_2O_5 is four.

15. A brown ring is formed in the ring test for NO_3^- ion. It is due to the formation of

(i) $[Fe(H_2O)_5(NO)]^{2+}$

(ii) $FeSO_4.NO_2$

(iii) $[Fe(H_2O)_4(NO)_2]^{2+}$

(iv) $FeSO_4.HNO_3$

16. Elements of group-15 form compounds in +5 oxidation state. However, bismuth forms only one well characterised compound in +5 oxidation state. The compound is

(i) Bi_2O_5

(ii) BiF_5

(iii) $BiCl_5$

(iv) Bi_2S_5

17. On heating ammonium dichromate and barium azide separately we get

(i) N_2 in both cases

(ii) N_2 with ammonium dichromate and NO with barium azide

(iii) N_2O with ammonium dichromate and N_2 with barium azide

(iv) N_2O with ammonium dichromate and NO_2 with barium azide

18. In the preparation of HNO_3, we get NO gas by catalytic oxidation of ammonia. The moles of NO produced by the oxidation of two moles of NH_3 will be _____.

(i) 2

(ii) 3

(iii) 4

(iv) 6

19. The oxidation state of central atom in the anion of compound NaH_2PO_2 will be _____.

(i) +3

(ii) +5

(iii) +1

(iv) –3

20. Which of the following is **not** tetrahedral in shape?

(i) NH_4^+

(ii) $SiCl_4$

(iii) SF_4

(iv) SO_4^{2-}

21. Which of the following are peroxoacids of sulphur?

(i) H_2SO_5 and $H_2S_2O_8$

(ii) H_2SO_5 and $H_2S_2O_7$

(iii) $H_2S_2O_7$ and $H_2S_2O_8$

(iv) $H_2S_2O_6$ and $H_2S_2O_7$

22. Hot conc. H_2SO_4 acts as moderately strong oxidising agent. It oxidises both metals and nonmetals. Which of the following element is oxidised by conc. H_2SO_4 into two gaseous products?

(i) Cu

(ii) S

(iii) C

(iv) Zn

23. A black compound of manganese reacts with a halogen acid to give greenish yellow gas. When excess of this gas reacts with NH_3 an unstable trihalide is formed. In this process the oxidation state of nitrogen changes from _____.

(i) – 3 to +3

(ii) – 3 to 0

(iii) – 3 to +5

(iv) 0 to – 3

24. In the preparation of compounds of Xe, Bartlett had taken $O_2^+ Pt F_6^-$ as a base compound. This is because

(i) both O_2 and Xe have same size.

(ii) both O_2 and Xe have same electron gain enthalpy.

(iii) both O_2 and Xe have almost same ionisation enthalpy.

(iv) both Xe and O_2 are gases.

25. In solid state PCl_5 is a _____.

(i) covalent solid

(ii) octahedral structure

(iii) ionic solid with $[PCl_6]^+$ octahedral and $[PCl_4]^-$ tetrahedra

(iv) ionic solid with $[PCl_4]^+$ tetrahedral and $[PCl_6]^-$ octahedra

26. Reduction potentials of some ions are given below. Arrange them in decreasing order of oxidising power.

Ion	ClO_4^-	IO_4^-	BrO_4^-
Reduction potential $E^\ominus/V$	$E^\ominus = 1.19V$	$E^\ominus = 1.65V$	$E^\ominus = 1.74V$

(i) $ClO_4^- > IO_4^- > BrO_4^-$

(ii) $IO_4^- > BrO_4^- > ClO_4^-$

(iii) $BrO_4^- > IO_4^- > ClO_4^-$

(iv) $BrO_4^- > ClO_4^- > IO_4^-$

27. Which of the following is isoelectronic pair?

(i) ICl_2, ClO_2

(ii) BrO_2^-, BrF_2^+

(iii) ClO_2, BrF

(iv) CN^-, O_3

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

28. If chlorine gas is passed through hot NaOH solution, two changes are observed in the oxidation number of chlorine during the reaction. These are _____ and _____.

(i) 0 to +5

(ii) 0 to +3

(iii) 0 to –1

(iv) 0 to +1

29. Which of the following options are **not** in accordance with the property mentioned against them?

(i)	$F_2 > Cl_2 > Br_2 > I_2$	Oxidising power.
(ii)	MI > MBr > MCl > MF	Ionic character of metal halide.
(iii)	$F_2 > Cl_2 > Br_2 > I_2$	Bond dissociation enthalpy.
(iv)	HI < HBr < HCl < HF	Hydrogen-halogen bond strength.

30. Which of the following is correct for P_4 molecule of white phosphorus?

(i) It has 6 lone pairs of electrons.

(ii) It has six P–P single bonds.

(iii) It has three P–P single bonds.

(iv) It has four lone pairs of electrons.

31. Which of the following statements are correct?

(i) Among halogens, radius ratio between iodine and fluorine is maximum.

(ii) Leaving F—F bond, all halogens have weaker X—X bond than X—X′ bond in interhalogens.

(iii) Among interhalogen compounds maximum number of atoms are present in iodine fluoride.

(iv) Interhalogen compounds are more reactive than halogen compounds.

32. Which of the following statements are correct for SO_2 gas?

(i) It acts as bleaching agent in moist conditions.

(ii) It's molecule has linear geometry.

(iii) It's dilute solution is used as disinfectant.

(iv) It can be prepared by the reaction of dilute H_2SO_4 with metal sulphide.

33. Which of the following statements are correct?

(i) All the three N—O bond lengths in HNO_3 are equal.

(ii) All P—Cl bond lengths in PCl_5 molecule in gaseous state are equal.

(iii) P_4 molecule in white phohsphorus have angular strain therefore white phosphorus is very reactive.

(iv) PCl is ionic in solid state in which cation is tetrahedral and anion is octahedral.

34. Which of the following orders are correct as per the properties mentioned against each?

(i)	$As_2O_3 < SiO_2 < P_2O_3 < SO_2$	Acid strength.
(ii)	$AsH_3 < PH_3 < NH_3$	Enthalpy of vapourisation.
(iii)	S < O < Cl < F	More negative electron gain enthalpy.
(iv)	$H_2O > H_2S > H_2Se > H_2Te$	Thermal stability.

35. Which of the following statements are correct?

(i) S–S bond is present in $H_2S_2O_6$.

(ii) In peroxosulphuric acid (H_2SO_5) sulphur is in +6 oxidation state.

(iii) Iron powder along with Al_2O_3 and K_2O is used as a catalyst in the preparation of NH_3 by Haber's process.

(iv) Change in enthalpy is positive for the preparation of SO_3 by catalytic oxidation of SO_2.

36. In which of the following reactions conc. H_2SO_4 is used as an oxidising reagent?

(i) $CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$

(ii) $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$

(iii) $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$

(iv) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

37. Which of the following statements are true?

(i) Only type of interactions between particles of noble gases are due to weak dispersion forces.

(ii) Ionisation enthalpy of molecular oxygen is very close to that of xenon.

(iii) Hydrolysis of XeF_6 is a redox reaction.

(iv) Xenon fluorides are not reactive.

III. Short Answer Type

38. In the preparation of H_2SO_4 by Contact Process, why is SO_3 not absorbed directly in water to form H_2SO_4?

39. Write a balanced chemical equation for the reaction showing catalytic oxidation of NH_3 by atmospheric oxygen.

40. Write the structure of pyrophosphoric acid.

41. PH_3 forms bubbles when passed slowly in water but NH_3 dissolves. Explain why?

42. In PCl_5, phosphorus is in sp^3d hybridised state but all its five bonds are not equivalent. Justify your answer with reason.

43. Why is nitric oxide paramagnetic in gaseous state but the solid obtained on cooling it is diamagnetic?

44. Give reason to explain why ClF_3 exists but FCl_3 does not exist.

45. Out of H_2O and H_2S, which one has higher bond angle and why?

46. SF_6 is known but SCl_6 is not. Why?

47. On reaction with Cl_2, phosphorus forms two types of halides 'A' and 'B'. Halide A is yellowish-white powder but halide 'B' is colourless oily liquid. Identify A and B and write the formulas of their hydrolysis products.

48. In the ring test of NO_3^- ion, Fe^{2+} ion reduces nitrate ion to nitric oxide, which combines with Fe^{2+} (aq) ion to form brown complex. Write the reactions involved in the formation of brown ring.

49. Explain why the stability of oxoacids of chlorine increases in the order given below:

$HClO < HClO_2 < HClO_3 < HClO_4$

50. Explain why ozone is thermodynamically less stable than oxygen.

51. P_4O_6 reacts with water according to equation $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$. Calculate the volume of 0.1 M NaOH solution required to neutralise the acid formed by dissolving 1.1 g of P_4O_6 in H_2O.

52. White phosphorus reacts with chlorine and the product hydrolyses in the presence of water. Calculate the mass of HCl obtained by the hydrolysis of the product formed by the reaction of 62 g of white phosphorus with chlorine in the presence of water.

53. Name three oxoacids of nitrogen. Write the disproportionation reaction of that oxoacid of nitrogen in which nitrogen is in +3 oxidation state.

54. Nitric acid forms an oxide of nitrogen on reaction with P_4O_{10}. Write the reaction involved. Also write the resonating structures of the oxide of nitrogen formed.

55. Phosphorus has three allotropic forms — (i) white phosphorus (ii) red phosphorus and (iii) black phosphorus. Write the difference between white and red phosphorus on the basis of their structure and reactivity.

56. Give an example to show the effect of concentration of nitric acid on the formation of oxidation product.

57. PCl_5 reacts with finely divided silver on heating and a white silver salt is obtained, which dissolves on adding excess aqueous NH_3 solution. Write the reactions involved to explain what happens.

58. Phosphorus forms a number of oxoacids. Out of these oxoacids phosphinic acid has strong reducing property. Write its structure and also write a reaction showing its reducing behaviour.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

59. Match the compounds given in Column I with the hybridisation and shape given in Column II and mark the correct option.

Column I	**Column II**
(A) XeF_6	(1) sp^3d^3 – distorted octahedral
(B) XeO_3	(2) sp^3d^2 - square planar
(C) $XeOF_4$	(3) sp^3 - pyramidal
(D) XeF_4	(4) $sp^3 d^2$ - square pyramidal

Code :

(i)	A (1)	B (3)	C (4)	D (2)
(ii)	A (1)	B (2)	C (4)	D (3)
(iii)	A (4)	B (3)	C (1)	D (2)
(iv)	A (4)	B (1)	C (2)	D (3)

60. Match the formulas of oxides given in Column I with the type of oxide given in Column II and mark the correct option.

Column I	**Column II**
(A) Pb_3O_4	(1) Neutral oxide
(B) N_2O	(2) Acidic oxide
(C) Mn_2O_7	(3) Basic oxide
(D) Bi_2O_3	(4) Mixed oxide

Code :

(i)	A (1)	B (2)	C (3)	D (4)
(ii)	A (4)	B (1)	C (2)	D (3)
(iii)	A (3)	B (2)	C (4)	D (1)
(iv)	A (4)	B (3)	C (1)	D (2)

61. Match the items of Columns I and II and mark the correct option.

Column I	**Column II**
(A) H_2SO_4	(1) Highest electron gain enthalpy
(B) CCl_3NO_2	(2) Chalcogen
(C) Cl_2	(3) Tear gas
(D) Sulphur	(4) Storage batteries

Code :

(i)	A (4)	B (3)	C (1)	D (2)
(ii)	A (3)	B (4)	C (1)	D (2)
(iii)	A (4)	B (1)	C (2)	D (3)
(iv)	A (2)	B (1)	C (3)	D (4)

62. Match the species given in Column I with the shape given in Column II and mark the correct option.

Column I	**Column II**
(A) SF_4	(1) Tetrahedral
(B) BrF_3	(2) Pyramidal
(C) BrO_3^-	(3) Sea-saw shaped
(D) NH_4^+	(4) Bent T-shaped

Code :

(i)	A (3)	B (2)	C (1)	D (4)
(ii)	A (3)	B (4)	C (2)	D (1)
(iii)	A (1)	B (2)	C (3)	D (4)
(iv)	A (1)	B (4)	C (3)	D (2)

63. Match the items of Columns I and II and mark the correct option.

Column I	**Column II**
(A) Its partial hydrolysis does not change oxidation state of central atom	(1) He
(B) It is used in modern diving apparatus	(2) XeF_6
(C) It is used to provide inert atmosphere for filling electrical bulbs	(3) XeF_4
(D) Its central atom is in sp^3d^2 hybridisation	(4) Ar

Code :

(i)	A (1)	B (4)	C (2)	D (3)
(ii)	A (1)	B (2)	C (3)	D (4)
(iii)	A (2)	B (1)	C (4)	D (3)
(iv)	A (1)	B (3)	C (2)	D (4)

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.

(ii) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.

(iii) Assertion is correct, but reason is wrong statement.

(iv) Assertion is wrong but reason is correct statement.

(v) Both assertion and reason are wrong statements.

64. **Assertion** : N_2 is less reactive than P_4.
Reason : Nitrogen has more electron gain enthalpy than phosphorus.

65. **Assertion** : HNO_3 makes iron passive.
Reason : HNO_3 forms a protective layer of ferric nitrate on the surface of iron.

66. **Assertion** : HI cannot be prepared by the reaction of KI with concentrated H_2SO_4

Reason : HI has lowest H–*X* bond strength among halogen acids.

67. **Assertion** : Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists as O_2.

Reason : Oxygen forms pπ – pπ multiple bond due to small size and small bond length but pπ – pπ bonding is not possible in sulphur.

68. **Assertion** : NaCl reacts with concentrated H_2SO_4 to give colourless fumes with pungent smell. But on adding MnO_2 the fumes become greenish yellow.

Reason : MnO_2 oxidises HCl to chlorine gas which is greenish yellow.

69. **Assertion** : SF_6 cannot be hydrolysed but SF_4 can be.

Reason : Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6.

VI. Long Answer Type

70. An amorphous solid "A" burns in air to form a gas "B" which turns lime water milky. The gas is also produced as a by-product during roasting of sulphide ore. This gas decolourises acidified aqueous $KMnO_4$ solution and reduces Fe^{3+} to Fe^{2+}. Identify the solid "A" and the gas "B" and write the reactions involved.

71. On heating lead (II) nitrate gives a brown gas "A". The gas "A" on cooling changes to colourless solid "B". Solid "B" on heating with NO changes to a blue solid 'C'. Identify 'A', 'B' and 'C' and also write reactions involved and draw the structures of 'B' and 'C'.

72. On heating compound (A) gives a gas (B) which is a constituent of air. This gas when treated with 3 mol of hydrogen (H_2) in the presence of a catalyst gives another gas (C) which is basic in nature. Gas C on further oxidation in moist condition gives a compound (D) which is a part of acid rain. Identify compounds (A) to (D) and also give necessary equations of all the steps involved.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)	2. (ii)	3. (i)	4. (iii)	5. (i)	6. (i)
7. (iv)	8. (iii)	9. (iii)	10. (iii)	11. (ii)	12. (i)
13. (iii)	14. (i)	15. (i)	16. (ii)	17. (i)	18. (i)
19. (iii)	20. (iii)	21. (i)	22. (iii)	23. (i)	24. (iii)
25. (iv)	26. (iii)	27. (ii)			

II. Multiple Choice Questions (Type-II)

28. (i), (iii) 29. (ii), (iii) 30. (ii), (iv) 31. (i), (iii), (iv)

32. (i), (iii) 33. (iii), (iv) 34. (i), (iv) 35. (i), (ii)

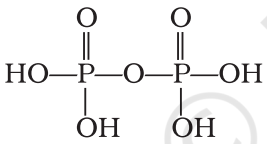
36. (ii), (iii) 37. (i), (ii)

III. Short Answer Type

38. Acid fog is formed, which is difficult to condense.

39. $4NH_3 + 5O_2 \xrightarrow[500K,\ 9\ bar]{Pt/Rh\ gauge\ catalyst} 4NO + 6H_2O$

(From air)

40. 

Pyrophosphoric acid

41. NH_3 forms hydrogen bonds with water therefore it is soluble in it but PH_3 cannot form hydrogen bond with water so it escapes as gas.

42. [**Hint :** It has trigonal bipyramidal geometry]

43. In gaseous state NO_2 exists as monomer which has one unpaired electron but in solid state it dimerises to N_2O_4 so no unpaired electron is left hence solid form is diamagnetic.

44. Because fluorine is more electronegative as compared to chlorine.

45. Bond angle of H_2O is larger, because oxygen is more electronegative than sulphur therefore bond pair electron of O–H bond will be closer to oxygen and there will be more bond-pair bond-pair repulsion between bond pairs of two O–H bonds.

46. Due to small size of fluorine six F^- ion can be accomodated around sulphur whereas chloride ion is comparatively larger in size, therefore, there will be interionic repulsion.

47. A is PCl_5 (It is yellowish white powder)

$$P_4 + 10Cl_2 \longrightarrow 4PCl_5$$

B is PCl_3 (It is a colourless oily liquid)

$$P_4 + 6Cl_2 \longrightarrow 4PCl_3$$

Hydrolysis products are formed as follows :

$$PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$$

$$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$$

48. $NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow NO + 3Fe^{3+} + 2H_2O$

$[Fe(H_2O)_6]^{2+} + NO \longrightarrow [Fe(H_2O)_5(NO)]^{2+} + H_2O$

(brown complex)

49. Oxygen is more electronegative than chlorine, therefore dispersal of negative charge present on chlorine increases from ClO^- to ClO_4^- ion because number of oxygen atoms attached to chlorine is increasing. Therefore, stability of ions will increase in the order given below :

$$ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$$

Thus due to increase in stability of conjugate base, acidic strength of corresponding acid increases in the following order

$$HClO < HClO_2 < HClO_3 < HClO_4$$

50. See the NCERT textbook for Class XII, page 186.

51. $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$

$H_3PO_3 + 2NaOH \longrightarrow Na_2HPO_3 + 2H_2O] \times 4$ (Neutralisation reaction)

$P_4O_6 + 8NaOH \longrightarrow 4Na_2HPO_4 + 2H_2O$

1 mol 8 mol

Product formed by 1 mol of P_4O_6 is neutralised by 8 mols of NaOH

$\therefore$ Product formed by $\frac{1.1}{220}$ mol of P_4O_6 will be neutralised by $\frac{1.1}{220} \times 8$ mol of NaOH

Molarity of NaOH solution is 0.1M

$\Rightarrow$ 0.1 mol NaOH is present in 1 L solution

$\therefore \frac{1.1}{220} \times 8$ mol NaOH is present in $\frac{1.1 \times 8}{220 \times 0.1}$ L $= \frac{88}{220}$ L $= \frac{4}{10}$ L $= 0.4$ L $=$ 400 mL of NaOH solution.

52. $P_4 + 6Cl_2 \longrightarrow 4PCl_3$

$PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl] \times 4$

$P_4 + 6Cl_2 + 12H_2O \longrightarrow 4H_3PO_3 + 12HCl$

1 mol of white phosphorus produces 12 mol of HCl

62g of white phosphorus has been taken which is equivalent to $\frac{62}{124} = \frac{1}{2}$ mol.

Therefore 6 mol HCl will be formed.

Mass of 6 mol HCl = 6 × 36.5 = 219.0 g HCl

53. Three oxoacids of nitrogen are

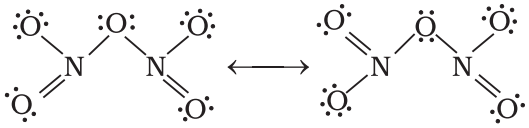
(i) HNO_2, Nitrous acid

(ii) HNO_3 , Nitric acid

(iii) Hyponitrous acid, $H_2N_2O_2$

$$3HNO_2 \xrightarrow{\text{Disproportionation}} HNO_3 + H_2O + 2NO$$

54. $4HNO_3 + P_4O_{10} \longrightarrow 4HPO_3 + 2N_2O_5$



55. (a)
- Structures (See NCERT textbook for Class XII)
- White phosphorus is discrete tetrahedral molecule. Thus it has tetrahedral structure with six P–P bonds.
- Red phosphorus has polymeric structure in which P_4 tetrahedra are linked together through P—P bonds to form chain.

(b) Reactivity

White phosphorus is much more reactive than red phosphorus. This is because in white phosphorus there is angular strain in P_4 molecules because the bond angles are only of 60°.

56. Dilute and concentrated nitric acid give different oxidation products on reaction with copper metal.

$$3Cu + 8HNO_3 \text{ (dil.)} \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

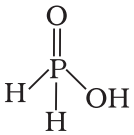
$$Cu + 4HNO_3 \text{ (Conc.)} \longrightarrow 3Cu(NO_3)_2 + 2NO + 2H_2O$$

57. $PCl_5 + 2Ag \longrightarrow 2AgCl + PCl_3$

$AgCl + 2NH_3(aq) \longrightarrow [Ag(NH_3)_2]^+Cl^-$

(soluble complex)

58. Structure of phosphinic acid (Hypophosphorous acid) is as follows :



Reducing behaviour of phosphinic acid is observable in the reaction with silver nitrate given below :

$$4AgNO_3 + 2H_2O + H_3PO_2 \longrightarrow 4Ag + 4HNO_3 + H_3PO_4$$

IV. Matching Type

59. (i) 60. (ii) 61. (i) 62. (ii) 63. (iii)

V. Assertion and Reason Type

64. (iii) 65. (iii) 66. (ii) 67. (i) 68. (i) 69. (i)

VI. Long Answer Type

70. 'A' is S_8 'B' is SO_2 gas

$$S_8 + 8O_2 \xrightarrow{\Delta} 8SO_2$$

$$2MnO_4^- + 5SO_2 + 2H_2O \longrightarrow 5\,SO_4^{2-} + 4H^+ + 2Mn^{2+}$$

(violet) (colourless)

$$2Fe^{3+} + SO_2 + 2H_2O \longrightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$$

71. $Pb(NO_3)_2 \xrightarrow[673K]{\Delta} 2PbO + 4NO_2$

(A)

(Brown colour)

$$2NO_2 \underset{\text{Heating}}{\overset{\text{On cooling}}{\rightleftharpoons}} N_2O_4$$

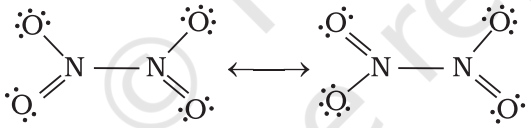
(B)

(Colourless solid)

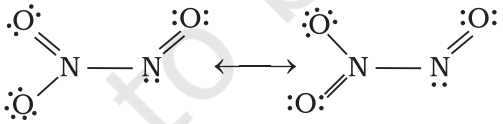
$$2NO + N_2O_4 \xrightarrow{\Delta\ 250\ K} 2\,N_2O_3$$

(C)

(Blue solid)



(Structure of N_2O_4)



(Structure of N_2O_3)

72. A = NH_4NO_2 B = N_2 C = NH_3 D = HNO_3

(i) $NH_4NO_2 \rightarrow N_2 + 2H_2O$

(ii) $N_2 + 3H_2 \rightarrow 2NH_3$

(iii) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

$4NO + O_2 \rightarrow 2NO_2$

$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$