SSNL
CHEMISTRY XII (2022-23)
(SUMMER VACATION ASSIGNMENT)

1. Calculate the mass percentage of benzene (C_6H_6) and carbon tetrachloride (CCl_4) if 22 g of benzene is dissolved in 122 g of carbon tetrachloride.
2. Calculate the mole fraction of benzene in solution containing 30% by mass in carbon tetrachloride.
3. Calculate the molarity of each of the following solutions: (a) 30 g of $Co(NO_3)_2$. $6H_2O$ in 4.3 L of solution (b) 30 mL of 0.5 M H_2SO_4 diluted to 500 mL.
4. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molal aqueous solution.
5. Calculate (a) molality (b) molarity and (c) mole fraction of KI if the density of 20% (mass/mass) aqueous KI is 1.202 g mL^{-1}.
6. H_2S, a toxic gas with rotten egg like smell, is used for the qualitative analysis. If the solubility of H_2S in water at STP is 0.195 m, calculate Henry's law constant.
7. Henry's law constant for CO_2 in water is $1.67x10^8$ Pa at 298 K. Calculate the quantity of CO_2 in 500 mL of soda water when packed under 2.5 atm CO_2 pressure at 298 K.
8. The vapour pressure of pure liquids A and B are 450 and 700 mm Hg respectively, at 350 K . Find out the composition of the liquid mixture if total vapour pressure is 600 mm Hg. Also find the composition of the vapour phase.
9. Vapour pressure of pure water at 298 K is 23.8 mm Hg. 50 g of urea (NH_2CONH_2) is dissolved in 850 g of water. Calculate the vapour pressure of water for this solution and its relative lowering.
10. Boiling point of water at 750 mm Hg is 99.63°C. How much sucrose is to be added to 500 g of water such that it boils at 100°C.
11. Calculate the mass of ascorbic acid (Vitamin C, $C_6H_8O_6$) to be dissolved in 75 g of acetic acid to lower its melting point by 1.5°C. K_f = 3.9 K kg mol^{-1}. 2.12 Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 mL of water at 37°C.
12. Define the term solution. How many types of solutions are formed? Write briefly about each type with an example.
13. Give an example of a solid solution in which the solute is a gas.
14. Define the following terms:

    (i) Mole fraction (ii) Molality (iii) Molarity (iv) Mass percentage.
15. Concentrated nitric acid used in laboratory work is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of the solution is 1.504 g mL^{-1}?
16. A solution of glucose in water is labelled as 10% w/w, what would be the molality and mole fraction of each component in the solution? If the density of solution is 1.2 g mL^{-1}, then what shall be the molarity of the solution?
17. How many mL of 0.1 M HCl are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of both?

18. A solution is obtained by mixing 300 g of 25% solution and 400 g of 40% solution by mass. Calculate the mass percentage of the resulting solution.

19. An antifreeze solution is prepared from 222.6 g of ethylene glycol ($C_2H_6O_2$) and 200 g of water. Calculate the molality of the solution. If the density of the solution is 1.072 g mL^{-1}, then what shall be the molarity of the solution?

20. A sample of drinking water was found to be severely contaminated with chloroform ($CHCl_3$) supposed to be a carcinogen. The level of contamination was 15 ppm (by mass):

(i) express this in percent by mass

(ii) determine the molality of chloroform in the water sample.

21. What role does the molecular interaction play in a solution of alcohol and water?

22. Why do gases always tend to be less soluble in liquids as the temperature is raised?

23. State Henry's law and mention some important applications.

24. The partial pressure of ethane over a solution containing 6.56×10^{-3} g of ethane is 1 bar. If the solution contains 5.00×10^{-2} g of ethane, then what shall be the partial pressure of the gas?

25. What is meant by positive and negative deviations from Raoult's law and how is the sign of $\Delta_{mix}H$ related to positive and negative deviations from Raoult's law?

26. An aqueous solution of 2% non-volatile solute exerts a pressure of 1.004 bar at the normal boiling point of the solvent. What is the molar mass of the solute?

27. Heptane and octane form an ideal solution. At 373 *K*, the vapour pressures of the two liquid components are 105.2 kPa and 46.8 kPa respectively. What will be the vapour pressure of a mixture of 26.0 g of heptane and 35 g of octane?

28. The vapour pressure of water is 12.3 kPa at 300 *K*. Calculate vapour pressure of 1 molal solution of a non-volatile solute in it.

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

30. A solution containing 30 g of non-volatile solute exactly in 90 g of water has a vapour pressure of 2.8 kPa at 298 *K*. Further, 18 g of water is then added to the solution and the new vapour pressure becomes 2.9 kPa at 298 *K*. Calculate: (i) molar mass of the solute (ii) vapour pressure of water at 298 *K*.

31. A 5% solution (by mass) of cane sugar in water has freezing point of 271*K*. Calculate the freezing point of 5% glucose in water if freezing point of pure water is 273.15 *K*.

32. Two elements A and B form compounds having formula AB_2 and AB_4. When dissolved in 20 g of benzene (C_6H_6), 1 g of AB_2 lowers the freezing point by 2.3 *K* whereas 1.0 g of AB_4 lowers it by 1.3 *K*. The molar depression constant for benzene is 5.1 *K* kg mol^{-1}. Calculate atomic masses of A and B.

33. At 300 K, 36 g of glucose present in a litre of its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of the solution is 1.52 bars at the same temperature, what would be its concentration?

34. Suggest the most important type of intermolecular attractive interaction in the following pairs.

(i) n-hexane and n-octane

(ii) I_2 and CCl_4

(iii) $NaClO_4$ and water

(iv) methanol and acetone

(v) acetonitrile (CH_3CN) and acetone (C_3H_6O).

35. Based on solute-solvent interactions, arrange the following in order of increasing solubility in n-octane and explain. Cyclohexane, KCl, CH_3OH, CH_3CN.

36. Amongst the following compounds, identify which are insoluble, partially soluble and highly soluble in water?

(i) phenol (ii) toluene (iii) formic acid

(iv) ethylene glycol (v) chloroform (vi) pentanol.

37. If the density of some lake water is 1.25g mL^{-1} and contains 92 g of Na^+ ions per kg of water, calculate the molarity of Na^+ ions in the lake.

38. If the solubility product of CuS is 6×10^{-16}, calculate the maximum molarity of CuS in aqueous solution.

39. Calculate the mass percentage of aspirin ($C_9H_8O_4$) in acetonitrile (CH_3CN) when 6.5 g of $C_9H_8O_4$ is dissolved in 450 g of CH_3CN.

40. Nalorphene ($C_{19}H_{21}NO_3$), similar to morphine, is used to combat withdrawal symptoms in narcotic users. Dose of nalorphene generally given is 1.5 mg. Calculate the mass of $1.5 \cdot 10^{-3}$ m aqueous solution required for the above dose.

41. Calculate the amount of benzoic acid (C_6H_5COOH) required for preparing 250 mL of 0.15 M solution in methanol.

42. The depression in freezing point of water observed for the same amount of acetic acid, trichloroacetic acid and trifluoroacetic acid increases in the order given above. Explain briefly.

43. Calculate the depression in the freezing point of water when 10 g of $CH_3CH_2CHClCOOH$ is added to 250 g of water. $K_a = 1.4 \times 10^{-3}$, $K_f = 1.86$ K kg mol^{-1}.

44. 19.5 g of CH_2FCOOH is dissolved in 500 g of water. The depression in the freezing point of water observed is 1.0^0 C. Calculate the van't Hoff factor and dissociation constant of fluoroacetic acid.

45. Vapour pressure of water at 293 *K* is 17.535 mm Hg. Calculate the vapour pressure of water at 293 *K* when 25 g of glucose is dissolved in 50 g of water.

46. Henry's law constant for the molality of methane in benzene at 298 *K* is 4.27 × 10^5 mm Hg. Calculate the solubility of methane in benzene at 298 *K* under 760 mm Hg.

47. 100 g of liquid A (molar mass 140 g mol^{-1}) was dissolved in 1000 g of liquid B (molar mass 180 g mol^{-1}). The vapour pressure of pure liquid B was found to be 500 torr. Calculate the vapour pressure of pure liquid A and its vapour pressure in the solution if the total vapour pressure of the solution is 475 Torr.

48. Benzene and toluene form ideal solution over the entire range of composition. The vapour pressure of pure benzene and toluene at 300 *K* are 50.71 mm Hg and 32.06 mm Hg respectively. Calculate the mole fraction of benzene in vapour phase if 80 g of benzene is mixed with 100 g of toluene.

49. The air is a mixture of a number of gases. The major components are oxygen and nitrogen with approximate proportion of 20% is to 79% by volume at 298 *K*. The water is in equilibrium with air at a pressure of 10 atm. At 298 *K* if the Henry's law constants for oxygen and nitrogen at 298 *K* are 3.30 × 10^7 mm and 6.51 × 10^7 mm respectively, calculate the composition of these gases in water.

50. Determine the amount of $CaCl_2$ (i = 2.47) dissolved in 2.5 litre of water such that its osmotic pressure is 0.75 atm at 27° C.

51. Determine the osmotic pressure of a solution prepared by dissolving 25 mg of K_2SO_4 in 2 litre of water at 25° C, assuming that it is completely dissociated.

52. Arrange the following metals in the order in which they displace each other from the solution of their salts.

Al, Cu, Fe, Mg and Zn.

53. Given the standard electrode potentials,

K^+/K = –2.93V, Ag^+/Ag = 0.80V,

Hg^{2+}/Hg = 0.79V

Mg^{2+}/Mg = –2.37 V, Cr^{3+}/Cr = – 0.74V

Arrange these metals in their increasing order of reducing power.

54. Depict the galvanic cell in which the reaction

$Zn(s)+2Ag^+(aq) \rightarrow Zn^{2+}(aq)+2Ag(s)$ takes place. Further show:

(i) Which of the electrode is negatively charged?

(ii) The carriers of the current in the cell.

(iii) Individual reaction at each electrode.

55. Calculate the standard cell potentials of galvanic cell in which the following reactions take place:

(i) $2Cr(s) + 3Cd^{2+}(aq) \rightarrow 2Cr^{3+}(aq) + 3Cd$

(ii) $Fe^{2+}(aq) + Ag^+(aq) \rightarrow Fe^{3+}(aq) + Ag(s)$

Calculate the $\Delta_r G^J$ and equilibrium constant of the reactions.

56. Write the Nernst equation and emf of the following cells at 298 K: (i) $Mg(s)|Mg^{2+}(0.001M)||Cu^{2+}(0.0001\ M)|Cu(s)$

(ii) $Fe(s)|Fe^{2+}(0.001M)||H^+(1M)|H_2(g)(1bar)|\ Pt(s)$

(iii) $Sn(s)|Sn^{2+}(0.050\ M)||H^+(0.020\ M)|H_2(g)\ (1\ bar)|Pt(s)$

(iv) $Pt(s)|Br^-(0.010\ M)|Br_2(l\ )||H^+(0.030\ M)|\ H_2(g)\ (1\ bar)|Pt(s)$.

57. In the button cells widely used in watches and other devices the following reaction takes place:

$Zn(s) + Ag_2O(s) + H_2O(l) \rightarrow Zn^{2+}(aq) + 2Ag(s) + 2OH^-(aq)$

Determine $\Delta_r G^J$ and E^J for the reaction.

58. Define conductivity and molar conductivity for the solution of an electrolyte. Discuss their variation with concentration.

59. The conductivity of 0.20 M solution of KCl at 298 K is 0.0248 S cm^{-1}. Calculate its molar conductivity.

60. The resistance of a conductivity cell containing 0.001M KCl solution at 298 K is 1500 Ω. What is the cell constant if conductivity of 0.001M KCl solution at 298 K is 0.146×10^{-3} S cm^{-1}.

61. The conductivity of sodium chloride at 298 K has been determined at different concentrations and the results are given below:

Concentration/M	0.001	0.010	0.020	0.050	0.100
$10^2 \times \kappa$/S m^{-1}	1.237	11.85	23.15	55.53	106.74

Calculate Λ_m for all concentrations and draw a plot between Λ_m and $c^{½}$. Find the value of ${}^0\Lambda_m$.

62. Conductivity of 0.00241 M acetic acid is 7.896×10^{-5} S cm^{-1}. Calculate its molar conductivity. If ${}^0\Lambda_m$ for acetic acid is 390.5 S cm^2 mol^{-1}, what is its dissociation constant?

63. How much charge is required for the following reductions:

(i) 1 mol of Al^{3+} to Al?

(ii) 1 mol of Cu^{2+} to Cu?

(iii) 1 mol of MnO_4^- to Mn^{2+}?

64. How much electricity in terms of Faraday is required to produce (i) 20.0 g of Ca from molten $CaCl_2$? (ii) 40.0 g of Al from molten Al_2O_3?

65. How much electricity is required in coulomb for the oxidation of (i) 1 mol of H_2O to O_2? (ii) 1 mol of FeO to Fe_2O_3?

66. A solution of $Ni(NO_3)_2$ is electrolysed between platinum electrodes using a current of 5 amperes for 20 minutes. What mass of Ni is deposited at the cathode?

67. Three electrolytic cells A,B,C containing solutions of $ZnSO_4$, $AgNO_3$ and $CuSO_4$, respectively are connected in series. A steady current of 1.5 amperes was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow? What mass of copper and zinc were deposited?

68. Using the standard electrode potentials given in Table 3.1, predict if the reaction between the following is feasible:

(i) Fe^{3+}(aq) and I^-(aq)

(ii) Ag^+ (aq) and Cu(s)

(iii) Fe^{3+} (aq) and Br^- (aq)

(iv) Ag(s) and Fe^{3+} (aq)

(v) Br_2 (aq) and Fe^{2+} (aq).

69. Predict the products of electrolysis in each of the following:

(i) An aqueous solution of $AgNO_3$ with silver electrodes.

(ii) An aqueous solution of $AgNO_3$ with platinum electrodes.

(iii) A dilute solution of H_2SO_4 with platinum electrodes.

(iv) An aqueous solution of $CuCl_2$ with platinum electrodes.

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CHEMISTRY XI (2022-23)

SUMMER VACATION ASSIGNMENT

1. Calculate the molar mass of the following:

(i) H_2O (ii) CO_2 (iii) CH_4

2. Calculate the mass per cent of different elements present in sodium sulphate (Na_2SO_4).
3. Determine the empirical formula of an oxide of iron, which has 69.9% iron and 30.1% dioxygen by mass.
4. Calculate the amount of carbon dioxide that could be produced when (i) 1 mole of carbon is burnt in air.
   (ii) 1 mole of carbon is burnt in 16 g of dioxygen.
   (iii) 2 moles of carbon are burnt in 16 g of dioxygen.
5. Calculate the mass of sodium acetate (CH_3COONa) required to make 500 mL of 0.375 molar aqueous solution. Molar mass of sodium acetate is 82.0245 g mol^{-1}.
6. Calculate the concentration of nitric acid in moles per litre in a sample which has a density, 1.41 g mL^{-1} and the mass per cent of nitric acid in it being 69%.
7. How much copper can be obtained from 100 g of copper sulphate ($CuSO_4$)?
8. Determine the molecular formula of an oxide of iron, in which the mass per cent of iron and oxygen are 69.9 and 30.1, respectively.
9. Calculate the atomic mass (average) of chlorine using the following data: % Natural Abundance Molar Mass
   ^{35}Cl 75.77 34.9689
   ^{37}Cl 24.23 36.9659
10. In three moles of ethane (C_2H_6), calculate the following:
   (i) Number of moles of carbon atoms.
   (ii) Number of moles of hydrogen atoms.
   (iii) Number of molecules of ethane.
11. What is the concentration of sugar ($C_{12}H_{22}O_{11}$) in mol L^{-1} if its 20 g are dissolved in enough water to make a final volume up to 2L?
12. If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution?
13. Pressure is determined as force per unit area of the surface. The SI unit of pressure, pascal is as shown below:
   $1Pa = 1N\ m^{-2}$
   If mass of air at sea level is 1034 g cm^{-2}, calculate the pressure in pascal.
14. What is the SI unit of mass? How is it defined?
15. Match the following prefixes with their multiples:

Prefixes	Multiples
(i) micro	10^6
(ii) deca	10^9
(iii) mega	10^{-6}
(iv) giga	10^{-15}
(v) femto	10

16. What do you mean by significant figures?
17. A sample of drinking water was found to be severely contaminated with chloroform, $CHCl_3$, supposed to be carcinogenic in nature. The level of contamination was 15 ppm (by mass).
   (i) Express this in per cent by mass.
   (ii) Determine the molality of chloroform in the water sample.
18. Express the following in the scientific notation:
   (i) 0.0048
   (ii) 234,000
   (iii) 8008
   (iv) 500.0

(v) 6.0012

19. How many significant figures are present in the following?

(i) 0.0025

(ii) 208

(iii) 5005

(iv) 126,000

(v) 500.0

(vi) 2.0034

20. Round up the following upto three significant figures:

(i) 34.216

(ii) 10.4107

(iii) 0.04597

(iv) 2808

21. The following data are obtained when dinitrogen and dioxygen react together to form different compounds:

	Mass of dinitrogen	Mass of dioxygen
(i)	14 g	16 g
(ii)	14 g	32 g
(iii)	28 g	32 g
(iv)	28 g	80 g

(a) Which law of chemical combination is obeyed by the above experimental data? Give its statement.

(b) Fill in the blanks in the following conversions:

(i) 1 km = ... mm = ... pm

(ii) 1 mg = ... kg = ... ng

(iii) 1 mL = ... L = ... dm^3

22. If the speed of light is 3.0×10^8 m s^{-1}, calculate the distance covered by light in 2.00 ns.

23. In a reaction

$A + B_2 \delta AB_2$

Identify the limiting reagent, if any, in the following reaction mixtures.

(i) 300 atoms of A + 200 molecules of B

(ii) 2 mol A + 3 mol B

(iii) 100 atoms of A + 100 molecules of B

(iv) 5 mol A + 2.5 mol B

(v) 2.5 mol A + 5 mol B

24. Dinitrogen and dihydrogen react with each other to produce ammonia according to the following chemical equation:

$N_2(g) + H_2^{(g)} \delta 2NH_3(g)$

(i) Calculate the mass of ammonia produced if $2.00 \cdot 10^3$ g dinitrogen reacts with $1.00 \cdot 10^3$ g of dihydrogen.

(ii) Will any of the two reactants remain unreacted?

(iii) If yes, which one and what would be its mass?

25. How are 0.50 mol Na_2CO_3 and 0.50 M Na_2CO_3 different?

26. If 10 volumes of dihydrogen gas reacts with five volumes of dioxygen gas, how many volumes of water vapour would be produced?

27. Convert the following into basic units:

(i) 28.7 pm

(ii) 15.15 pm

(iii) 25365 mg

28. Which one of the following will have the largest number of atoms?

    (i) 1 g Au (s)

    (ii) 1 g Na (s)

    (iii) 1 g Li (s)

    (iv) 1 g of Cl_2(g)

29. Calculate the molarity of a solution of ethanol in water, in which the mole fraction of ethanol is 0.040 (assume the density of water to be one).

30. What will be the mass of one ^{12}C atom in g?

31. How many significant figures should be present in the answer of the following calculations?

    (i) $0.02856 \cdot 298.15 \cdot 0.112 \cdot 0.5785$

    (ii) $5 \cdot 5.364$

    (iii) 0.0125 + 0.7864 + 0.0215

32. Use the data given in the following table to calculate the molar mass of naturally occurring *argon* isotopes:

Isotope	Isotopic molar mass	Abundance
^{36}Ar	35.96755 g mol^{-1}	0.337%
^{38}Ar	37.96272 g mol^{-1}	0.063%
^{40}Ar	39.9624 g mol^{-1}	99.600%

33. Calculate the number of atoms in each of the following (i) 52 moles of Ar (ii) 52 u of He (iii) 52 g of He.

34. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. Calculate (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula.

35. Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction,

$$CaCO_3\ (s) + 2\ HCl\ (aq) \rightarrow CaCl_2\ (aq) + CO_2(g) + H_2O(l)$$

36. What mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl? 1.36 Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueous hydrochloric acid according to the reaction

$$4\ HCl\ (aq) + MnO_2(s) \rightarrow 2H_2O\ (l) + MnCl_2(aq) + Cl_2\ (g)$$

How many grams of HCl react with 5.0 g of manganese dioxide?

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33. Calculate the number of atoms in each of the following (i) 52 moles of Ar (ii) 52 u of He (iii) 52 g of He.

34. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. Calculate (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula.

35. Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction,

    $$CaCO_3\,(s) + 2\,HCl\,(aq) \rightarrow CaCl_2\,(aq) + CO_2(g) + H_2O(l)$$

36. What mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl? 1.36 Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueous hydrochloric acid according to the reaction

    $$4\,HCl\,(aq) + MnO_2(s) \rightarrow 2H_2O\,(l) + MnCl_2(aq) + Cl_2\,(g)$$

    How many grams of HCl react with 5.0 g of manganese dioxide?