Exercises

Single Correct Answer Type

Henry's Law

1. At same temperature, oxygen is more soluble in water than hydrogen. Which of them will have a higher value of K_H?

   (1) Oxygen (2) Hydrogen

   (3) Both have equal value (4) Can't predict

2. Henry's law is valid only when:

   (1) Pressure is low

   (2) Temperature is low

   (3) The gas is not highly soluble

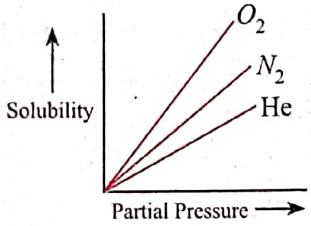
   (4) The gas neither reacts chemically with solvent nor dissociates or associates in the solvent.

3. Air contins O_2 and N_2 in the ratio of 1 : 4. Calculate the ratio of solubilities in terms of mole fractions of N_2 and O_2 dissolved in water at atmospheric pressure and at room temperature at which Henry's constant for O_2 and N_2 are 3.30×10^7 and 6.60×10^7 torr respectively.

   (1) 1 : 2 (2) 2 : 1

   (3) 3 : 1 (4) 1 : 3

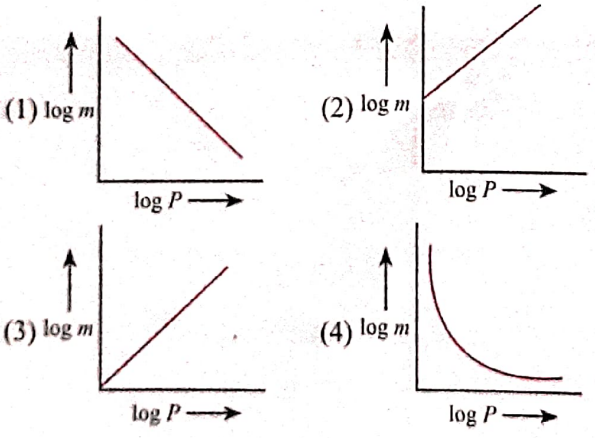
4. Molar solubility of helium, nitrogen and oxygen are plotted against partial pressure of the gas at constant temperature. Henry's law constant for these gases will lie in following sequence?



   (1) $O_2 > N_2 > He$ (2) $O_2 < N_2 < He$

   (3) $O_2 = N_2 = He$ (4) $O_2 > N_2 < He$

5. According to William Henry's the solubility of a gas in liquid depends on the pressure of the gas. If 'm' is the molality of the gas and 'P' is its pressire, then which of the following plot is in accordance with the law?



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

   (1) Mole fraction (2) Parts per million

   (3) Mass percentage (4) Molality

7. A sample of water is contamniated with 30 ppm of arsenic (As). The molality of As in water is (Aw of As = 75.0 g)

   (1) 2×10^{-2} (2) 4×10^{-2}

   (3) 2×10^{-3} (4) 4×10^{-3}

8. K_H (Henry's law constant) for CO_2 in water at 25°C is 3.0×10^{-2} mol L^{-1} atm^{-1}. What is the concentration of CO_2 in soft drink that is bottled with a partial pressure of CO_2 of 5 atm. over the liquid at 25°C

   (1) 0.15 M (2) 0.015 M

   (3) 0.30 M (4) 0.03 M

Raoult's Law, Ideal and Non-Ideal Solution, Azeotrope

9. 0.2 mole of liquid A is dissolved in 4.0 mole of H_2O. Total pressure of solution is 0.210 bar at 37°C. The vapour pressure of pure liquid (vapour pressure of water at 37°C = 0.198 bar) in bar is

   (1) 0.448 (2) 44.8

   (3) 0.224 (4) 2.24

10. Two liquids A and B form an ideal solution. The vapour pressure of pure A and pure B are 66 mm Hg and 88 mm Hg, respectively. Calculate the composition of vapour A in the solution which is equilibrium and whose molar volume is 36%.

    (1) 0.43 (2) 0.70

    (3) 0.30 (4) 0.50

11. At 27°C. the vapour pressure of an ideal solution containing 1 mole of A and 1 mole of B is 500 mm of Hg. At the same temperature, if 2 mol of B is added to this solution the vapour pressure of solution increases by 50 mm of Hg. The vapour pressure of A and B in their pure states is respectively,

    (1) 600 mm, 400 mm (2) 400 mm, 600 mm

    (3) 300 mm, 700 mm (4) 200 mm, 800 mm

12. Mixture of volatile components A and B has total vapour pressure (in torr) : $P_{total} = 254 - 119\chi_A$

    where χ_A is the mole fraction of A in mixture. Hence p_A° and p_B° are (in torr):

    (1) 254, 119 (2) 119, 254

    (3) 135, 254 (4) 154, 119

13. Negative deviations from Raoult's law are exhibited by binary mixtures

    (1) in which the molecules tend to attract each other and hence their escape into the vapour phase is retarded.

    (2) in which the molecules tend to repel each other and hence their escape into the vapour phase is retarded.

    (3) in which the molecules tend to attract each other and hence their escape into the vapour phase is speeded up.

(4) in which the molecules tend to repel each other and hence their escape into the vapour phase is speeded up.

14. Mole fraction of component A in vapour phase is χ_1 and mole fraction of component A in liquid mixture is χ_2(p_A° = vapour pressure of pure A), then the total vapour pressure of the liquid mixture is

(1) $\frac{p_A^\circ \chi_2}{\chi_1}$ (2) $\frac{p_A^\circ \chi_1}{\chi_2}$

(3) $\frac{p_B^\circ \chi_1}{\chi_2}$ (4) $\frac{p_B^\circ \chi_2}{\chi_1}$

15. At 25°C, the vapour pressure of pure methyl alcohol is 92.0 torr. Mol fraction of CH_3OH in a solution in which vapour pressure of CH_3OH is 23.0 torr at 25°C, is:

(1) 0.25 (2) 0.75

(3) 0.50 (4) 0.66

16. The vapour pressure of pure benzene C_6H_6 at 50°C is 268 torr. How many moles of non-volatile solute per mole of benzene are required to prepare a solution of benzene having a vapour pressure of 167 torr at 50°C?

(1) 0.377 (2) 0.605

(3) 0.623 (4) 0.395

17. The vapour pressure of pure liquid solvent A is 0.80 atm. When a non-volatile substance B is added to the solvent, its vapour pressure drops to 0.60 atm; the mole fraction of component B in the solution is

(1) 0 (2) 0.25

(3) 2.0 (4) 3.0

18. The vapour pressure of a pure liquid A is 40 mm Hg at 310 K. The vapour pressure of this liquid in a solution with liquid B is 32 mm Hg. The mole fraction of A in the solution, if it obeys Raoult's law, is:

(1) 0.8 (2) 0.5

(3) 0.2 (4) 0.4

19. The boiling point of an azeotropic mixture of water and ethyl alcohol is less than that of the theoretical value of water and alcohol mixture. Hence the mixture shows

(1) The solution is highly saturated.

(2) Positive deviation from Raoult's law.

(3) Negative deviation from Raoult's law.

(4) Nothing can be said.

20. Solution distilled without change in composition at a temperature is called

(1) Amorphous (2) Azeotropic mixture

(3) Ideal solution (4) Super saturated solution

21. Azeotropic mixtures are

(1) Constant boiling point mixture without changing the composition.

(2) Those which boil at different temperatures.

(3) Mixtures of two solids.

(4) None of the above

22. On mixing 10 mL of acetone with 40 mL of chloroform, the total volume of the solution is

(1) <50 mL (2) >50 mL

(3) =50 mL (4) Cannot be predicted

23. Which of the following substances will lose its solubility with increase in temperature?

(1) NaOH (2) Na_2CO_3 (3) Na_2SO_4 (4) All

24. On mixing 10 mL of carbon tetrachloride with 10 mL of benzene, the total volume of the solution is

(1) >20 mL (2) <20 mL

(3) =20 mL (4) Cannot be predicted

25. If Raoult's law is obeyed, the vapour pressure of the solvent in a solution is directly proportional to

(1) The mole fraction of the solvent.

(2) The mole fraction of the solute.

(3) The mole fraction of the solvent and solute.

(4) The volume of the solution.

26. Each pair forms ideal solution except

(1) C_2H_5Br and C_2H_5I

(2) C_6H_5Cl and C_6H_5Br

(3) C_6H_6 and $C_6H_5{\cdot}CH_3$

(4) C_2H_5I and C_2H_5OH

27. An aqueous solution of methanol in water has vapour pressure

(1) Equal to that of water

(2) Equal to that of methanol

(3) More than that of water

(4) Less than that of water

28. Which condition is not satisfied by an ideal solution?

(1) $\Delta_{mix}H = 0$

(2) $\Delta_{mix}V = 0$

(3) $\Delta_{mix}S = 0$

(4) Obeyance of Raoult's law

29. A mixture of benzene and toluene forms

(1) An ideal solution (2) Non-ideal solution

(3) Suspension (4) Emulsion

30. A pressure cooker reduces cooking time because

(1) Heat is more evenly distributed

(2) Boiling point of water inside the cooker is increased

(3) The high pressure tenderizes the food

(4) All of these

31. If P° and P_s are vapour pressures of solvent and its solution, respectively, χ_1 and χ_2 are mole fractions of solvent and solute, respectively, then

(1) $P_s = P^\circ/\chi_2$

(2) $P^\circ - P_s = P^\circ\chi_2$

(3) $P_s = P^\circ\chi_2$

(4) $\frac{P^\circ - P_s}{P_s} = \frac{\chi_1}{\chi_1 + \chi_2}$

32. Dry air was passed successively through a solution of 5 g of a solute in 180 g of water and then through pure water.

61. 100 g of $C_6H_{12}O_6$(aq) solution has vapour pressure is equal to 40 torr at certain temperature. Vapour pressure of H_2O(l) is 40.18 torr at same temperature. If this solution is cooled to –0.93°C, what mass of ice will be separeted out? (K_f = 1.86 kg mol^{-1})
(1) 95.5 g (2) 4.5 g
(3) 45.5 g (4) 47.8 g

Colligative Properties and Vant Hoff Factor

62. An aqueous solution freezes at –2.55°C. What is its boiling point ($K_{b(H_2O)}$ = 0.52 K m^{-1}; $K_f^{H_2O}$ = 1.86 K m^{-1})?
(1) 107.0°C (2) 100.6°C (3) 100.1°C (4) 100.7°C

63. The relative decrease in VP of an aqueous glucose dilute solution is found to be 0.018. Hence, the elevation in boiling point is (it is given 1 molal aqueous urea solution boils at 100.54°C at 1 atm pressure)
(1) 0.018° (2) 0.18° (3) 0.54° (4) 0.03°

64. 10.0 g of glucose (π_1), 10.0 g of urea (π_2), and 10.0 g of sucrose (π_3) are dissolved in 250.0 mL of water at 273 K (π = osmotic pressure of a solution). The relationship between the osmotic pressure of the solutions is
(1) $\pi_1 > \pi_2 > \pi_3$ (2) $\pi_3 > \pi_1 > \pi_2$
(3) $\pi_2 > \pi_1 > \pi_3$ (4) $\pi_2 > \pi_3 > \pi_1$

65. 0.6 g of a solute is dissolved in 0.1 L of a solvent which develops an osmotic pressure of 1.23 atm at 27°C. The molecular weight of the solute is
(1) 149.5 g mol^{-1} (2) 120.0 g mol^{-1}
(3) 430.0 g mol^{-1} (4) None of these

66. A 5% solution of cane sugar (molecular weight = 342) is isotonic with a 1% solution of substance X. The molecular weight of X is
(1) 342 (2) 171.12 (3) 65.6 (4) 136.8

67. What mass of urea be dissolved in 171 g of water so as to decrease the vapour pressure of water by 5%?
(1) 15 g (2) 20 g (3) 25 g (4) 30 g

68. The vapour pressure at a given temperature of an ideal solution containing 0.2 mol of non-volatile solute and 0.8 mol of a solvent is 60 mm of Hg. The vapour pressure of the pure solvent at the same temperature will be
(1) 120 mm Hg (2) 150 mm Hg
(3) 60 mm Hg (4) 75 mm Hg

69. The vapour pressure of a solution containing 5.0 g of a non-electrolyte in 100.0 g of water at a particular temperature is 2985 N m^{-2}. If the vapour pressure of pure water is 3000 N m^{-2}, the molecular weight of the solute is
(1) 60.0 (2) 120.0
(3) 180.0 (4) 380.0

70. The molal boiling point constant for water is 0.513 K m^{-1}. When 0.1 mole of sugar is dissolved in 200.0 g of water, the solution boils under a pressure 1.0 atm at
(1) 100.513°C (2) 100.0513°C
(3) 100.256°C (4) 101.025°C

71. What should be the boiling point of 1.0 molal aqueous KCl solution (assuming complete dissociation of KCl) if $K_{b(H_2O)}$ is 0.52 K m^{-1}?
(1) 100.52°C (2) 101.04°C
(3) 99.48°C (4) 98.96°C

72. The ratio of freezing point depression values of 0.01 M solutions of urea, common salt, and Na_2SO_4 are
(1) 1:1:1 (2) 1:2:1 (3) 1:2:3 (4) 2:2:3

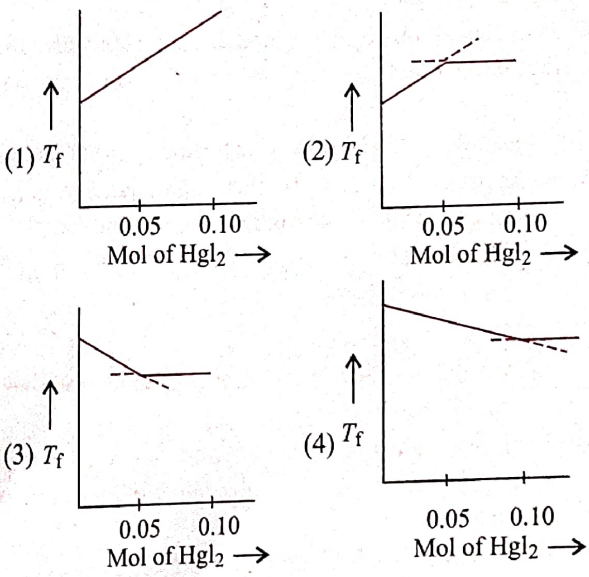
73. From a measurement of the freezing point depression of benzene, the molecular weight of acetic acid in a benzene solution was determined to be 100. The percentage association of acetic acid is
(1) 79% (2) 93% (3) 80% (4) 100%

74. An aqueous solution containing an ionic salt having molality equal to 0.19 freezes at –0.704°C. The Van't Hoff factor of the ionic salt is (K_f for water = 1.86 K m^{-1})
(1) 3 (2) 2 (3) 4 (4) 5

75. The Van't Hoff factor for a 0.1 M $Al_2(SO_4)_3$ solution is 4.20. The degree of dissociation is
(1) 80% (2) 90% (3) 78% (4) 83%

76. The degree of dissociation α of a weak electrolyte is
(1) $\frac{i-1}{n+1}$ (2) $\frac{i-1}{n-1}$
(3) $\frac{n-1}{i-1}$ (4) $\frac{n+1}{i-1}$
where n is the number of ions given by 1 mol of electrolyte.

77. Increasing amount of solid HgI_2 is added to 1 L of an aqueous solution containing 0.1 mol KI. Which of the following graphs do represent the variation of freezing point of the resulting solution with the amount of HgI_2 added?



78. Equimolal solutions of KCl and compound X in water show depression in freezing point in the ratio of 4:1. Assuming KCl to be completely ionized, the compound X in solution must
(1) Dissociate to the extent of 50%
(2) Hydrolyze to the extent of 80%
(3) Dimerize to the extent of 50%
(4) Trimerize to the extent of 75%