# CHEMISTRY (CODE – 043)

## Chapter-wise Test: Solutions

(NCERT Class XII Chemistry, Unit 1: Solutions)

## SOLUTIONS AND MARKING SCHEME

## CLASS XII (2026-27)

**Time: 1½ hours** **Max. Marks: 35**

Step-by-step solutions with the distribution of marks. Marks for each step are shown in square brackets [ ]. Any other correct method or answer should be given full credit.

**Quick answer key – Section A**

| Q. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Ans. | C | D | B | D | B | A | C | A |

### SECTION A

Questions 1 to 8 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions. Each question carries 1 mark.

| | | |
|---|---|---|
| **1** | **Answer: C. Molality**<br>Molality = moles of solute / mass of solvent in kg. Mass does not change with temperature, whereas volume does. Molarity, normality and volume percentage all involve volume, so they change with temperature. | 1 |
| **2** | **Answer: D**<br>By Henry's law, $p = K_H x$, so the slope of each line in Fig. 1 equals $K_H$. Line X is steeper, so $K_H(X) > K_H(Y)$. Since $x = p/K_H$, the gas with the larger $K_H$ has the smaller mole fraction in solution at the same $p$, i.e. X is less soluble than Y. | 1 |
| **3** | **Answer: B. $O_2$**<br>Higher the value of $K_H$, lower is the solubility of the gas at a given pressure ($x = p/K_H$). $O_2$ has the lowest $K_H$ (34.86 kbar), so it is the most soluble. Order of solubility: $O_2 > H_2 > N_2 >$ He. | 1 |
| **4** | **Answer: D. Benzene and toluene**<br>In an ideal solution the A–B interactions are nearly equal to the A–A and B–B interactions, so $\Delta_{mix}H = 0$ and $\Delta_{mix}V = 0$. Benzene–toluene (like *n*-hexane–*n*-heptane) is nearly ideal. Acetone–chloroform and phenol–aniline show negative deviation; ethanol–water shows positive deviation. | 1 |
| **5** | **Answer: B. Nitric acid and water**<br>Solutions showing a large **negative** deviation from Raoult's law form maximum boiling azeotropes. Nitric acid–water (about 68% $HNO_3$ by mass, b.p. 393.5 K) is the example. The other three show positive deviation and form minimum boiling azeotropes. | 1 |
| **6** | **Answer: A. $Al_2(SO_4)_3$**<br>Depression in freezing point is a colligative property: $\Delta T_f = i\,K_f m$. For equal concentrations, the solution giving the most particles has the lowest freezing point. $Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3SO_4^{2-}$ ($i = 5$), $CaCl_2$ ($i = 3$), NaCl ($i = 2$), glucose ($i = 1$). | 1 |
| **7** | **Answer: C. 0.4 m**<br>Moles of NaOH = 4 g / 40 g mol$^{-1}$ = 0.1 mol [step 1]. Mass of solvent = 250 g = 0.25 kg. Molality = 0.1 mol / 0.25 kg = **0.4 mol kg$^{-1}$**. | 1 |
| **8** | **Answer: A. Both A and R are true, and R is the correct explanation of A.**<br>Dissolution of a gas in a liquid is an exothermic process, so by Le Chatelier's principle solubility decreases with rise in temperature ($K_H$ increases). Cold water therefore holds more dissolved oxygen, which sustains aquatic life, so R explains A. | 1 |

## SECTION B

Question Nos. 9 to 11 are very short answer questions carrying 2 marks each.

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| **9** | **(A)**<br>(i) In (a) the experimental $p_{total}$ curve lies **above** the dotted line expected for an ideal solution: **positive deviation**. In (b) the curve lies **below** the dotted line: **negative deviation**. [1]<br>(ii) (a) ethanol + acetone (or $CS_2$ + acetone, ethanol + water); (b) chloroform + acetone (or phenol + aniline, $HNO_3$ + water). [1]<br>**(B)**<br>(i) Solutions that obey Raoult's law over the entire range of concentration are ideal solutions. For them $\Delta_{mix}H = 0$ and $\Delta_{mix}V = 0$. [1]<br>(ii) *n*-Hexane and *n*-heptane (also benzene + toluene, bromoethane + chloroethane). [1] | 1 + 1 |
| **10** | **(A)**<br>(i) At constant temperature, the partial pressure of a gas in the vapour phase ($p$) is proportional to the mole fraction of the gas ($x$) in the solution: $\boldsymbol{p = K_H x}$. [1]<br>(ii) Under high pressure, more atmospheric gases (mainly $N_2$) dissolve in the blood. On rapid ascent the pressure falls suddenly, the dissolved gases are released and form bubbles of nitrogen in the blood, which block the capillaries. [1]<br>**(B)**<br>(i) By Henry's law the solubility of $CO_2$ increases with its partial pressure, so sealing the bottle under high pressure increases the amount of dissolved $CO_2$. [1]<br>(ii) At high altitude the partial pressure of oxygen is low, so its concentration in the blood and tissues is low (Henry's law). [1] | 1 + 1 |
| **11** | **(A)**<br>Take 100 g of solution: 30 g ethylene glycol and 70 g water. n(glycol) = 30/62 = 0.484 mol; n(water) = 70/18 = 3.889 mol. [1]<br>$x$(glycol) = 0.484 / (0.484 + 3.889) = 0.484 / 4.373 = **0.111** [1]<br>**(B)**<br>n(NaOH) = 10 g / 40 g $mol^{-1}$ = 0.25 mol; V = 250 mL = 0.25 L. [1]<br>Molarity = 0.25 mol / 0.25 L = **1.0 mol $L^{-1}$ (1 M)** [1] | 1 + 1 |

## SECTION C

Question Nos. 12 to 15 are short answer questions carrying 3 marks each.

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| **12** | **(A)**<br>(i) **Carbon tetrachloride**, because it has the highest $K_f$ (31.8 K kg $mol^{-1}$); $\Delta T_f = K_f m$. [1]<br>(ii) For benzene $K_f$ = 5.12 K kg $mol^{-1}$. $M_2 = K_f \times w_2 \times 1000 / (\Delta T_f \times w_1)$ [1]<br>$M_2$ = (5.12 × 3.0 × 1000) / (0.64 × 100) = 15360 / 64 = **240 g $mol^{-1}$** [1]<br>**(B)**<br>(i) Molality = (6.0/60) mol / 0.200 kg = 0.5 mol $kg^{-1}$. For water $K_b$ = 0.52. $\Delta T_b$ = 0.52 × 0.5 = 0.26 K. [1]<br>Boiling point of the solution = 373.15 + 0.26 = **373.41 K** [1]<br>(ii) **Carbon tetrachloride**, since its $K_b$ (5.03 K kg $mol^{-1}$) is the highest. [1] | 1 + 2 |

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| **13** | **(A)**<br>(i) On dilution the ions are far apart, so interionic attractions become negligible and dissociation is almost complete; the experimental *i* approaches the theoretical value. [1]<br>(ii) $Mg^{2+}$ and $SO_4^{2-}$ carry double charges, so the interionic attraction (ion-pair formation) is much stronger than in NaCl. Fewer free particles are present, so *i* is lower. [1]<br>(iii) $\Delta T_f = i\,K_f m = 2.70 \times 1.86 \times 0.01 = 0.0502 \approx$ **0.050 K** [1]<br>**(B)**<br>(i) *i* = observed colligative property / calculated colligative property = normal molar mass / abnormal molar mass = total moles of particles after association or dissociation / moles before. [1]<br>(ii) $K_2SO_4 \rightarrow 2K^+ + SO_4^{2-}$ (*n* = 3 particles). $i = 1 + (n - 1)\alpha$, i.e. $2.70 = 1 + 2\alpha$. [1]<br>$\alpha = 1.70 / 2 =$ **0.85** (85% dissociation) [1] | 1 + 1 + 1 |
| **14** | **(A)**<br>(i) **Curve 2** represents the solution. A non-volatile solute lowers the vapour pressure of the solvent (the solute particles occupy part of the surface), so at every temperature the solution curve lies below that of the pure solvent. [1]<br>(ii) A liquid boils when its vapour pressure becomes equal to the external (atmospheric) pressure. $T_1$ is the boiling point of the pure solvent and $T_2$ is the boiling point of the solution, because Curve 2 reaches 1.013 bar only at the higher temperature. [1]<br>(iii) $\Delta T_b = T_2 - T_1 = K_b\,m$, where $K_b$ is the molal elevation constant of the solvent and *m* the molality of the solute. [1]<br>**(B)**<br>$p_{total} = p_A^\circ + (p_B^\circ - p_A^\circ)x_B$, or in terms of $x_A$: $400 = 500 - (500 - 300)x_A$ [1]<br>$200\,x_A = 100$, so $\boldsymbol{x_A = 0.5}$ **and** $\boldsymbol{x_B = 0.5}$ [1]<br>Vapour phase: $y_A = (0.5 \times 300)/400 =$ **0.375**; $y_B = 1 - 0.375 =$ **0.625** [1] | 1 + 1 + 1 |
| **15** | **(A)**<br>(i) The spontaneous flow of solvent molecules from the pure solvent (or a more dilute solution) to the solution (or a more concentrated solution) through a semipermeable membrane. [1]<br>(ii) $\pi = n_2RT/V$. $n_2 = 9/180 = 0.05$ mol; $V = 0.5$ L. [1]<br>$\pi = (0.05 \times 0.083 \times 300) / 0.5 = 1.245 / 0.5 =$ **2.49 bar** [1]<br>**(B)**<br>(i) The relative lowering of vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute: $(p_1^\circ - p_1)/p_1^\circ = x_2$. [1]<br>(ii) *n*(urea) = 12/60 = 0.2 mol; *n*(water) = 180/18 = 10 mol; $x_2 = 0.2/10.2 = 0.0196$. [1]<br>$p_1 = 23.8 \times (1 - 0.0196) = 23.8 \times 10/10.2 =$ **23.33 mm Hg** [1] | 1 + 2 |

| SECTION D | | |
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| Question No. 16 is a case-based/data-based question carrying 4 marks. | | |
| **16** | (i) **P is isotonic, Q is hypotonic, R is hypertonic.** P has the same osmotic pressure as the cell fluid (no net flow). Q has a lower osmotic pressure than the cell fluid, and R has a higher osmotic pressure. [1]<br>(ii) **Osmosis** (endosmosis). The solvent (water) flows from the dilute solution Q, outside the cells, through the membrane into the more concentrated cell fluid, so the cells swell and burst. [1]<br>(iii) **(A)** R is hypertonic, so water flows out of the cells into the more concentrated solution (exosmosis) and the cells shrink. [1] If a pressure larger than the osmotic pressure is applied on the solution side, the solvent flows from the solution to the pure solvent through the membrane: **reverse osmosis**. [1]<br>**(B)** A 0.9% NaCl solution is isotonic with blood plasma (same osmotic pressure), so the RBCs neither swell nor shrink. [1] Reverse osmosis is used for desalination of sea water to obtain pure water. [1] | 1 + 1 + 2 |

| SECTION E | | |
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| Question No. 17 is a long answer question carrying 5 marks. | | |
| **17** | **(A)**<br>(i) Properties of dilute solutions that depend only on the number of solute particles and not on their nature: relative lowering of vapour pressure, elevation of boiling point, depression of freezing point and osmotic pressure (any two). [1]<br>(ii) $M_2 = K_f \times w_2 \times 1000 / (\Delta T_f \times w_1)$ [1] = (1.86 × 5.0 × 1000) / (0.372 × 250) = 9300 / 93 = **100 g mol$^{-1}$** [1]<br>(iii) Molality = (5.0/100) mol / 0.250 kg = 0.2 mol kg$^{-1}$; $\Delta T_b = 0.52 \times 0.2 = 0.104$ K. Boiling point = 373.15 + 0.104 = **373.25 K** [1]<br>(iv) NaCl dissociates into $Na^+$ and $Cl^-$ ($i \approx 2$), so it gives about twice as many particles as glucose, which does not dissociate. $\Delta T_f = i K_f m$ depends on the number of particles. [1]<br>**(B)**<br>(i) Osmotic pressure can be measured at room temperature and gives a measurable value even for very dilute solutions (about $10^{-3}$ M). Proteins and polymers have low solubility and cannot form concentrated solutions, so the other colligative effects are too small to measure. Also, molarity is used instead of molality. [1]<br>(ii) $C$ = (5.85/58.5) mol / 1 L = 0.1 mol L$^{-1}$. $\pi = iCRT$ [1] = 2 × 0.1 × 0.083 × 300 = **4.98 bar** [1]<br>(iii) $2CH_3COOH \rightleftharpoons (CH_3COOH)_2$. $i = 1 - \alpha/2 = 1 - 0.8/2 =$ **0.6** [1]<br>(iv) Abnormal molar mass = normal molar mass / $i$ = 60 / 0.6 = **100 g mol$^{-1}$** (higher than the normal value because of association) [1] | 5 |

**Topic coverage of the paper**

| Topic (NCERT section) | Questions |
|---|---|
| Types of solutions; expressing concentration (1.1, 1.2) | Q1, Q7, Q11 |
| Solubility of gases; Henry's law (1.3) | Q2 (graph), Q3 (table), Q8, Q10 |
| Vapour pressure, Raoult's law, ideal and non-ideal solutions, azeotropes (1.4, 1.5) | Q4, Q5, Q9 (figure), Q14 (B) |
| Colligative properties: $\Delta T_b$, $\Delta T_f$, osmosis (1.6) | Q6, Q12 (table), Q14 (A) (figure), Q15, Q16 (table), Q17 |
| Abnormal molar masses; van't Hoff factor (1.7) | Q6, Q13 (table), Q17 |

Figure/table-based questions (7): Q2, Q3, Q9, Q12, Q13, Q14 and Q16.