Class 12 Chemistry · Chapter 1: Solutions

Answer key and marking scheme · 20 marks · about 40 minutes · based on NCERT

Scan for the free Class 12 Chemistry test

1. For a salt X, $\Delta_{sol}H = +18$ kJ mol^{-1}. A nearly saturated solution of X is in contact with excess solid. When the temperature is raised, the solubility of X [1]

(a) first increases and then decreases

(b) decreases, since heat drives solute out of solution

(c) does not change, since solids are incompressible

(d) increases, since the equilibrium shifts in the endothermic direction

Answer: (d) $\Delta_{sol}H > 0$, so dissolution absorbs heat. By Le Chatelier's principle, raising the temperature favours the endothermic change, dissolution, and solubility rises. Incompressibility is the reason pressure, not temperature, has little effect.

2. In which of the following is a liquid the solute and a solid the solvent? [1]

(a) camphor in nitrogen gas

(b) solution of hydrogen in palladium

(c) copper dissolved in gold

(d) amalgam of mercury with sodium

Answer: (d) In sodium amalgam the liquid mercury is the solute in solid sodium (Table 1.1). Hydrogen in palladium is gas in solid, copper in gold solid in solid, camphor in nitrogen solid in gas.

3. 2.8 g of KOH (56 g mol^{-1}) is dissolved in water and the solution is made up to 250 mL. Its molarity is [1]

(a) 0.0112 M

(b) 0.050 M

(c) 0.20 M

(d) 2.0 M

Answer: (c) Moles of KOH = 2.8/56 = 0.050 mol; volume = 0.250 L; M = 0.050/0.250 = 0.20 M. 0.050 M forgets the volume; 0.0112 divides grams by millilitres.

4. A gas has a Henry's law constant of 50.0 kbar in water at 298 K. Its mole fraction in water in equilibrium with the gas at a partial pressure of 0.50 bar is [1]

(a) 1.0×10^{-5}

(b) 1.0×10^{-2}

(c) 1.0×10^{5}

(d) 2.5×10^{4}

Answer: (a) $p = K_H x$, so $x = p/K_H$ = 0.50 bar / 50 000 bar = 1.0×10^{-5}. 1.0×10^{-2} leaves K_H in kbar; 1.0×10^{5} inverts the ratio; 2.5×10^{4} multiplies.

5. Which of the following dissolves readily in benzene but hardly at all in water? [1]

(a) sodium chloride

(b) anthracene

(c) sugar

(d) potassium chloride

Answer: (b) Like dissolves like: non-polar anthracene dissolves in non-polar benzene. NaCl, KCl and sugar are polar or ionic and dissolve in water, not benzene.

6. (a) Why does a raw mango kept in brine shrivel? (b) Why is 0.9% (mass/volume) NaCl, and not pure water, injected into a patient's vein? [2]

(a) Brine is more concentrated than the cell fluid of the mango, so water leaves the mango cells by osmosis and it shrivels. (b) 0.9% NaCl (normal saline) is isotonic with blood-cell fluid, so no osmosis occurs; pure water is hypotonic and would flow into the cells and make them swell.

- water leaves the mango cells by osmosis into the more concentrated brine (1)
- normal saline is isotonic with blood-cell fluid, so cells neither swell nor shrink (1)

Every question original, written from NCERT, checked by a second reviewer · photocopy freely for your class

7. What is an azeotrope? Why can absolute ethanol not be obtained by fractional distillation of fermented liquor? [2]

An azeotrope is a binary mixture with the same composition in liquid and vapour, boiling at a constant temperature. Ethanol–water shows a large positive deviation and forms a minimum boiling azeotrope at about 95% ethanol by volume; once this composition is reached, liquid and vapour have the same composition and no further separation occurs.

- definition of azeotrope (1)
- minimum boiling azeotrope at about 95% ethanol stops separation (1)

8. When a cold bottle of soda water is opened, there is a mild fizz; when a warm one is opened, it fizzes much more. Explain both observations using Henry's law. [2]

The bottle is sealed under high CO_2 pressure. On opening, the partial pressure of CO_2 above the liquid falls; by Henry's law ($p = K_H\, x$) the solubility falls, and the extra gas escapes as bubbles. In the warm bottle K_H is larger, so even less CO_2 stays dissolved at the lower pressure, and more escapes.

- fall in partial pressure of CO_2 lowers its solubility (Henry's law) (1)
- higher K_H at higher temperature, so lower solubility and more fizz (1)

9. Liquids X and Y form an ideal solution; at 320 K, p_X° = 90 kPa and p_Y° = 30 kPa. (a) Find the mole fraction of X in the liquid whose vapour contains equal numbers of moles of X and Y, and the total vapour pressure over it. (b) For a liquid with $x_X = 0.50$, find y_X and say which component the vapour is richer in. [3]

(a) Equal moles in the vapour means $p_X = p_Y$: $90\, x_X = 30\,(1 - x_X)$, so $x_X = 0.25$. $p_{total} = 22.5 + 22.5 = 45$ kPa. (b) $p_X = 45$ kPa, $p_Y = 15$ kPa, $p_{total} = 60$ kPa; $y_X = 45/60 = 0.75$. The vapour is richer in X, the more volatile component.

- $p_X = p_Y$ set up and $x_X = 0.25$ (1)
- $p_{total} = 45$ kPa (1)
- $y_X = 0.75$, vapour richer in the more volatile X (1)

10. A compound has the empirical formula CH_2O. When 1.80 g of it is dissolved in 50.0 g of ethanol, the boiling point rises by 0.240 K. Find its molar mass and molecular formula. (K_b of ethanol = 1.20 K kg mol^{-1}; C = 12, H = 1, O = 16 g mol^{-1}) [3]

$M_2 = (1000 \times w_2 \times K_b)/(\Delta T_b \times w_1) = (1000 \times 1.80 \times 1.20)/(0.240 \times 50.0) = 180$ g mol^{-1}. Empirical formula mass of CH_2O = 30, so n = 180/30 = 6 and the molecular formula is $C_6H_{12}O_6$.

- correct expression for M_2 (1)
- $M_2 = 180$ g mol^{-1} (1)
- n = 6, molecular formula $C_6H_{12}O_6$ (1)

11. (a) A 3.42% (mass/volume) aqueous solution of sucrose (342 g mol^{-1}) is isotonic with an aqueous solution of urea (60 g mol^{-1}). Find the mass/volume percentage of urea. (b) Calculate the osmotic pressure of either solution at 300 K. (c) Would a 0.100 M NaCl solution be isotonic with them? (R = 0.083 L bar mol^{-1} K^{-1}) [3]

(a) Sucrose: 34.2 g L^{-1} ÷ 342 = 0.100 M. Isotonic solutions of non-electrolytes at the same temperature have the same molarity, so urea = 0.100 × 60 = 6.0 g L^{-1} = 0.60% (m/V). (b) $\Pi = CRT = 0.100 \times 0.083 \times 300 = 2.49$ bar. (c) No: NaCl gives two ions, $i \approx 2$, so its osmotic pressure is about twice as large.

- 0.60% urea by equal molarity (1)
- $\Pi = 2.49$ bar (1)
- NaCl not isotonic, since $i \approx 2$ doubles Π (1)