

Exercise – I (JEE-Main Pattern)

SECTION-A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.

Zero Marks : 0, if none of the bubbles is darkened.

Negative Marks : -1 in all other cases

- If four gases A, B, C and D have Henry's constant (K_H) values 1.9×10^1 , 6.5×10^{-4} , 7.8×10^{-4} and 6.0×10^3 bar respectively then which of the following gas has maximum solubility at same partial pressure ?
(1) A (2) B (3) C (4) D
CLQ001
- At a given temperature, total vapour pressure in Torr of a mixture of volatile components A and B is given by
 $P_{\text{Total}} = 120 - 75 X_B$
hence, vapour pressure of pure A and B respectively (in Torr) are
(1) 120, 75 (2) 120, 195 (3) 120, 45 (4) 75, 45
CLQ002
- Two liquids A & B form an ideal solution. What is the vapour pressure of solution containing 2 moles of A and 3 moles of B at 300 K? [Given : At 300 K, Vapour pr. of pure liquid A (P_A°) = 100 torr, Vapour pr. of pure liquid B (P_B°) = 300 torr]
(1) 200 torr (2) 140 torr (3) 180 torr (4) None of these
CLQ003
- The vapour pressure of a pure liquid 'A' is 70 torr at 27°C. It forms an ideal solution with another liquid B. The mole fraction of B is 0.2 and total vapour pressure of the solution is 84 torr at 27°C. The vapour pressure of pure liquid B at 27°C is
(1) 14 (2) 56 (3) 140 (4) 70
CLQ004
- At 88 °C benzene has a vapour pressure of 900 torr and toluene has a vapour pressure of 360 torr. What is the mole fraction of benzene in the mixture with toluene that will boil at 88 °C at 1 atm. pressure, benzene - toluene form an ideal
(1) 0.416 (2) 0.588 (3) 0.688 (4) 0.740
CLQ005
- The correct relationship between the boiling points of very dilute solutions of AlCl_3 (T_1) and CaCl_2 (T_2) having the same molar concentration is :
(1) $T_1 = T_2$ (2) $T_1 > T_2$ (3) $T_2 > T_1$ (4) $T_2 \geq T_1$
CLQ006

7. Cryoscopic constant of a liquid is:
 (1) decrease in freezing point when 1 gram of solute is dissolved per kg of the solvent
 (2) decrease in the freezing point when 1 mole of solute is dissolved per kg of the solvent
 (3) the elevation for 1 molar solution
 (4) a factor used for calculation of elevation in boiling point
CLQ007
8. At certain Hill-station pure water boils at 99.725°C. If K_b for water is 0.513°C kg mol⁻¹, the boiling point of 0.69 m solution of urea will be :
 (1) 100.079°C (2) 103°C (3) 100.359°C (4) un predictable
CLQ008
9. The freezing point of 1 molal NaCl solution assuming NaCl to be 100% dissociated in water is :
 ($K_f = 1.86 \text{ K kg mol}^{-1}$:
 (1) -1.86°C (2) -3.72°C (3) +1.86°C (4) +3.72°C
CLQ009
10. 10 gram of solute with molecular mass 100 gram mol⁻¹ is dissolved in 100 gram solvent to show 0.3°C elevation in boiling point. The value of molal ebullioscopic constant will be :
 (1) 10 (2) 3 (3) 0.3 (4) un predictable
CLQ010
11. The vapour pressure of pure A is 10 torr and at the same temperature when 1 g of B is dissolved in 20 gm of A, its vapour pressure is reduced to 9.0 torr. If the molecular mass of A is 200 amu, then the molecular mass of B is :
 (1) 100 amu (2) 90 amu (3) 75 amu (4) 120 amu
CLQ011
12. If the observed and theoretical molecular mass of NaCl is found to be 31.80 and 58.50, then the degree of dissociation of NaCl is :
 (1) 83.96% (2) 8.39% (3) 90% (4) 100%
CLQ012
13. Among the following, that does not form an ideal solution is :
 (1) C₆H₆ and C₆H₅CH₃ (2) C₂H₅Cl and C₆H₅OH
 (3) C₆H₅Cl and C₆H₅Br (4) C₂H₅Br and C₂H₅I
CLQ013
14. An azeotropic solution of two liquids has boiling point lower than either of them when it:
 (1) shows a negative deviation from Raoult's law
 (2) shows no deviation from Raoult's law
 (3) shows positive deviation from Raoult's law
 (4) is saturated
CLQ014
15. The vapour pressure of a pure liquid solvent (X) is decreased to 0.60 atm. from 0.80 atm on addition of a non-volatile substance (Y). The mole fraction of (Y) in the solution is:-
 (1) 0.20 (2) 0.25 (3) 0.5 (4) 0.75
CLQ015

16. A solution prepared by dissolving a 2.50 g sample of an unknown compound dissolved in 34.0 g of benzene, C_6H_6 boils at $1.38^\circ C$ higher than pure benzene. Which expression gives the molar mass of the unknown compound ?

Compound K_b
 C_6H_6 2.53 K kg/mol

(1) $2.53 \times \frac{2.50}{1.38}$

(2) $1.38 \times \frac{34.0}{2.53} \times 2.50$

(3) $2.50 \times 10^3 \times \frac{2.53}{34.0} \times \frac{1}{1.38}$

(4) $2.50 \times 10^3 \times \frac{1.38}{34.0} \times 2.53$

CLQ016

17. 12.2 gm benzoic acid ($M = 122$) in 100 g H_2O has elevation of boiling point of $0.27^\circ C$, $K_b = 0.54$ K kg/mole. If there is 100% association, the no. of molecules of benzoic acid in associated state is :

(1) 1 (2) 2 (3) 3 (4) 4

CLQ017

18. The molal boiling point constant of water is 0.573 K kg mole $^{-1}$. When 0.1 mole of glucose is dissolved in 1000 g of water, the solution boils under atmospheric pressure at :

(1) $100.513^\circ C$ (2) $100.0573^\circ C$ (3) $100.256^\circ C$ (4) $101.025^\circ C$

CLQ018

19. 5% (w/v) solution of sucrose ($M = 342$) is isotonic with 1% (w/v) solution of a compound 'A' then the molecular weight of compound 'A' is -

(1) 32.4 (2) 68.4 (3) 121.6 (4) 34.2

CLQ019

20. Molar volume of liquid A ($d = 0.8$ gm/ml) increase by factor of 2000 when it vaporises at 200K. Vapour pressure of liquid A at 200K is [$R = 0.08$ L-atm/mol-K]

(Molar mass of A = 80g/mol)

(1) 0.4 atm (2) 8 atm (3) 0.8 atm (4) 0.08 atm

CLQ020

SECTION-B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:
 Full Marks : +4, if only correct answer is given.
 Zero Marks : 0, if no answer is given.
 Negative Marks : -1 for incorrect answer

1. 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. What is the mole fraction of component B in the solution?

CLQ021

2. The vapour pressure of pure benzene at a certain temperature is 640 mm of Hg. A non-volatile nonelectrolyte solid weighing 2.175 g is added to 39.0 of benzene. The vapour pressure of the solution is 600 mm of Hg. What is molecular weight of solid substance?
CLQ022
3. A 6.84% solution (w/v) of cane-sugar (Mol. weight = 342) is isotonic with 0.8%(w/v) solution of non-volatile solute. Find molecular weight of solute.
CLQ023
4. A certain mass of a substance, when dissolved in 100 g C₆H₆, lowers the freezing point by 1.28°C. The same mass of solute dissolved in 100g water lowers the freezing point by 1.40°C. If the substance has normal molecular weight in benzene and is completely ionized in water, into how many ions does it dissociate in water? K_f for H₂O and C₆H₆ are 1.86 and 5.12K kg mol⁻¹.
CLQ024
5. If ΔT_1 = Elevation in B.P. of 0.1 m aq. solution of glucose in kelvin and ΔT_2 = Magnitude of depression in Freezing Point of 0.05 m aq. solution of KCl in kelvin then value of $\frac{\Delta T_2}{\Delta T_1}$ is ? (least possible value)
Given that : K_b and K_f for H₂O is 0.5 and 1.5 K kg mol⁻¹
CLQ025
6. Osmotic pressure of a solution containing 2 gm dissolved protein per 300 cm³ of solution is 20 mm of Hg at 27°C. The molecular mass of protein is (in gm mol⁻¹) : (R = 0.08 L-atm/mol-K)
CLQ026
7. 20 gm of a non-volatile solute B when added to 500 gm of a volatile solvent A, decreases the vapour pressure of A from 306 torr to 300 torr at 300 K. What is the molecular mass of non-volatile solute (g/mole). The molecular mass of solvent is 25 g/mole.
CLQ027
8. The osmotic pressure shown by 0.1 molar aqueous solution of a weak electrolyte AB is 3.6 atm at 300 K. Find % dissociation of weak electrolyte AB.
Use : R = 0.08 L-atm/K-mole. Sum the digits of your answer till you get single digit number.)
CLQ028
9. Find number of mixtures among following for which enthalpy change of mixture is zero.
benzene + toluene, n-hexane + n-heptane, ethyl bromide + ethyl iodide, CCl₄ + SiCl₄, CCl₄ + CHCl₃, acetone + benzene, C₂H₄Br₂ + C₂H₄Cl₂, C₂H₅Br + C₂H₅Cl, cyclohexane + ethanol
CLQ029
10. Oxygen gas is maintained at partial pressure of 0.81 atm above water sample. Henry's constant for dissolution of O₂ in water is 10⁵ atm. If molality of O₂ in water at equilibrium is (y × 10⁻⁴) final value of 'y'
CLQ030

Exercise – II (JEE-Main PYQs)

1. Elevation in the boiling point for 1 molal solution of glucose is 2 K. The depression in the freezing point of 2 molal solutions of glucose in the same solvent is 2 K. The relation between K_b and K_f is:

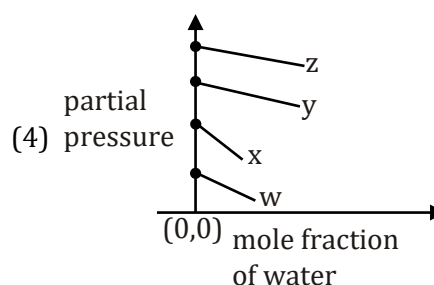
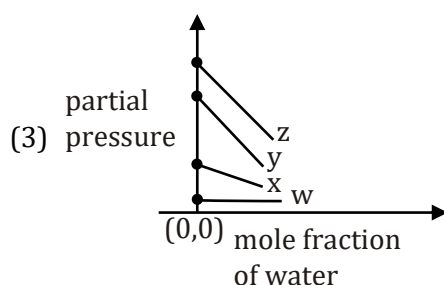
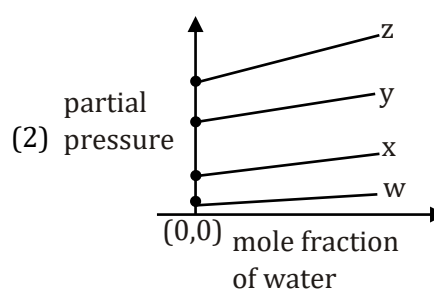
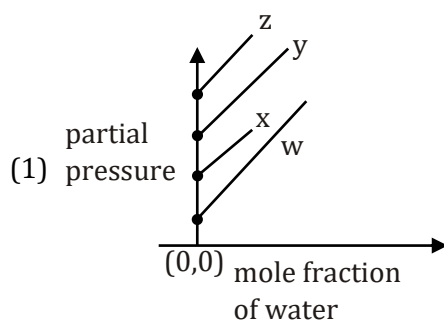
[JEE (Main) 2019]

- (1) $K_b = 0.5 K_f$ (2) $K_b = 2 K_f$ (3) $K_b = 1.5 K_f$ (4) $K_b = K_f$

CLQ033

2. For the solution of the gases w, x, y and z in water at 298K, the Henry's law constants (K_H) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is :-

[JEE (Main) 2019]



CLQ034

3. The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fraction of components A and B in vapour phase, respectively are

[JEE (Main) 2019]

- (1) 500 mm Hg, 0.5, 0.5 (2) 450 mm Hg, 0.4, 0.6
(3) 450 mm Hg, 0.5, 0.5 (4) 500 mm Hg, 0.4, 0.6

CLQ035

4. The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01 M BaCl_2 in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in mol L^{-1}) in solution is :

[JEE (Main) 2019]

- (1) 6×10^{-2} (2) 4×10^{-4}
(3) 16×10^{-4} (4) 4×10^{-2}

CLQ036

5. Liquid 'M' and liquid 'N' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mmHg, respectively, at the same temperature. Then correct statement is:

(x_M = Mole fraction of 'M' in solution ;

x_N = Mole fraction of 'N' in solution ;

y_M = Mole fraction of 'M' in vapour phase ;

y_N = Mole fraction of 'N' in vapour phase)

[JEE (Main) 2019]

(1) $(x_M - y_M) < (x_N - y_N)$

(2) $\frac{x_M}{x_N} < \frac{y_M}{y_N}$

(3) $\frac{x_M}{x_N} > \frac{y_M}{y_N}$

(4) $\frac{x_M}{x_N} = \frac{y_M}{y_N}$

CLQ037

6. 1 g of non-volatile non-electrolyte solute is dissolved in 100g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 5. The ratio of the elevation in their boiling points, $\frac{\Delta T_b(A)}{\Delta T_b(B)}$, is :

[JEE (Main) 2019]

(1) 5 : 1

(2) 10 : 1

(3) 1 : 5

(4) 1 : 0.2

CLQ038

7. Liquids A and B form an ideal solution. At 30°C, the total vapour pressure of a solution containing 1 mol of A and 2 moles of B is 250 mm Hg. The total vapour pressure becomes 300 mm Hg when 1 more mol of A is added to the first solution. The vapour pressures of pure A and B at the same temperature are :-

[JEE (Main) 2019]

(1) 450, 150 mm Hg

(2) 250, 300 mm Hg

(3) 125, 150 mm Hg

(4) 150, 450 mm Hg

CLQ039

8. At 35°C, the vapour pressure of CS₂ is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS₂ in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is :

[JEE (Main) 2020]

(1) heat must be absorbed in order to produce the solution at 35°C

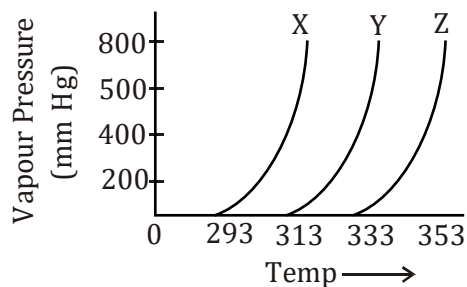
(2) Raoult's law is not obeyed by this system

(3) a mixture of 100 mL CS₂ and 100 mL acetone has a volume < 200 mL

(4) CS₂ and acetone are less attracted to each other than to themselves

CLQ040

9. A graph of vapour pressure and temperature for three different liquids X, Y and Z is shown below :



The following inferences are made :

- (A) X has higher intermolecular interactions compared to Y.
 (B) X has lower intermolecular interactions compared to Y.
 (C) Z has lower intermolecular interactions compared to Y.

The correct inference(s) is/are :

[JEE (Main) 2020]

- (1) A (2) (C) (3) (B) (4) (A) and (C)

CLQ041

10. How much amount of NaCl should be added to 600 g of water ($\rho = 1.00 \text{ g/mL}$) to decrease the freezing point of water to -0.2°C ? _____. (The freezing point depression constant for water = 2 K kg mol^{-1})

[JEE (Main) 2020]

CLQ042

11. If 250 cm^3 of an aqueous solution containing 0.73 g of a protein A is isotonic with one litre of another aqueous solution containing 1.65 g of a protein B, at 298 K, the ratio of the molecular masses of A and B is _____ $\times 10^{-2}$ (to the nearest integer).

[JEE (Main) 2020]

CLQ043

12. The osmotic pressure of a solution of NaCl is 0.10 atm and that of a glucose solution is 0.20 atm. The osmotic pressure of a solution formed by mixing 1 L of the sodium chloride solution with 2 L of the glucose solution is $x \times 10^{-3} \text{ atm}$. x is _____. (nearest integer) :-

[JEE (Main) 2020]

CLQ044

13. At 300 K, the vapour pressure of a solution containing 1 mole of n-hexane and 3 moles of n-heptane is 550 mm of Hg. At the same temperature, if one more mole of n-heptane is added to this solution, the vapour pressure of the solution increases by 10 mm of Hg. What is the vapour pressure in mm Hg of n-heptane in its pure state _____ ?

[JEE (Main) 2020]

CLQ045

14. 1 kg of 0.75 molal aqueous solution of sucrose can be cooled up to -4°C before freezing. The amount of ice (in g) that will be separated out is _____. (Nearest integer)

[Given : $K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}$]

[JEE (Main) 2021]

CLQ046

15. 1.22 g of an organic acid is separately dissolved in 100 g of benzene ($K_b = 2.6 \text{ K kg mol}^{-1}$) and 100 g of acetone ($K_b = 1.7 \text{ K kg mol}^{-1}$). The acid is known to dimerize in benzene but remain as a monomer in acetone. The boiling point of the solution in acetone increases by 0.17°C .

The increase in boiling point of solution in benzene in $^\circ\text{C}$ is $x \times 10^{-2}$. The value of x is _____. (Nearest integer)

[Atomic mass : C = 12.0, H = 1.0, O = 16.0]

[JEE (Main) 2021]

CLQ047

16. The depression in freezing point observed for a formic acid solution of concentration 0.5 mol L^{-1} is 0.0405°C . Density of formic acid is 1.05 g mL^{-1} . The Van't Hoff factor of the formic acid solution is nearly: (Given for water $k_f = 1.86 \text{ K kg mol}^{-1}$) [JEE (Main) 2022]
 (1) 0.8 (2) 1.1 (3) 1.9 (4) 2.4 CLQ048
17. In the depression of freezing point experiment
 A. Vapour pressure of the solution is less than that of pure solvent
 B. Vapour pressure of the solution is more than that of pure solvent
 C. Only solute molecules solidify at the freezing point
 D. Only solvent molecules solidify at the freezing point [JEE (Main) 2023]
 (1) A and D only (2) B and C only (3) A and C only (4) A only CLQ049
18. The Total pressure observed by mixing two liquid A and B is 350 mm Hg when their mole fractions are 0.7 and 0.3 respectively.
 The Total pressure becomes 410 mm Hg if the mole fractions are changed to 0.2 and 0.8 respectively for A and B. The vapour pressure of pure A is ____ mm Hg. (Nearest integer)
 Consider the liquids and solutions behave ideally. [JEE (Main) 2023]
CLQ050
19. Sea water contains 29.25% NaCl and 19% MgCl_2 by weight of solution. The normal boiling point of the sea water is ____ $^\circ\text{C}$ (Nearest integer)
 Assume 100% ionization for both NaCl and MgCl_2
 Given : $K_b(\text{H}_2\text{O}) = 0.52 \text{ K kg mol}^{-1}$
 Molar mass of NaCl and MgCl_2 is 58.5 and 95 g mol^{-1} respectively. [JEE (Main) 2023]
CLQ135
20. What weight of glucose must be dissolved in 100 g of water to lower the vapour pressure by 0.20 mm Hg? (Assume dilute solution is being formed)
 Given : Vapour pressure of pure water is 54.2 mm Hg at room temperature. Molar mass of glucose is 180 g mol^{-1} . [JEE (Main) 2023]
 (1) 4.69 g (2) 3.59 g (3) 2.59 g (4) 3.69 g CLQ136

Exercise - III (JEE Advanced Pattern)

SECTION-I

- This section contains **FIVE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:
Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : -1 in all other cases

1. A solution has a 1 : 4 mole ratio of pentane to hexane. The vapour pressures of the pure hydrocarbons at 20°C are 440 mmHg for pentane and 120 mmHg for hexane. The mole fraction of pentane in the vapour phase would be :-
 (A) 0.200 (B) 0.48 (C) 0.549 (D) 0.786

CLQ051

2. If two liquids, A and B are mixed together at 25°C to form a solution in which $X_B = 0.92$, then total vapour pressure of solution is observed to be 0.95 atm. If vapour pressure of pure A and pure B are 300 torr and 800 torr respectively at 25°C, then correct option for this solution is -
 (A) $\Delta H_{\text{mix}} > 0$, $\Delta V_{\text{mix}} > 0$ (B) $\Delta H_{\text{mix}} < 0$, $\Delta V_{\text{mix}} < 0$
 (C) $\Delta H_{\text{mix}} = 0$, $\Delta V_{\text{mix}} = 0$ (D) $\Delta H_{\text{mix}} < 0$, $\Delta V_{\text{mix}} > 0$

CLQ052

3. Two liquids A and B are mixed at temperature T in a certain ratio to form an ideal solution. It is found that the partial vapour pressure of A i.e. P_A is equal to P_B , the vapour pressure of B for the liquid mixture. What is the total vapour pressure of the liquid mixture in terms of P_A° and P_B° (the vapour pressure of the pure liquids A and B at the temperature) ?
 (A) $\frac{P_A^\circ P_B^\circ}{P_A^\circ + P_B^\circ}$ (B) $\frac{P_A^\circ}{P_A^\circ + P_B^\circ}$ (C) $\frac{2P_A^\circ P_B^\circ}{P_A^\circ + P_B^\circ}$ (D) $\frac{2P_B^\circ}{P_A^\circ + P_B^\circ}$

CLQ053

4. Which of the following plots represents an ideal binary mixture?
 (A) Plot of P_{total} v/s $1/X_B$ is linear (X_B = mole fraction of 'B' in liquid phase).
 (B) Plot of P_{total} v/s Y_A is linear (Y_B = mole fraction of 'A' in vapour phase)
 (C) Plot of $\frac{1}{P_{\text{total}}}$ v/s Y_A is linear
 (D) Plot of $\frac{1}{P_{\text{total}}}$ v/s Y_B is non-linear

CLQ054

5. For which of the following Vant' Hoff factor is correctly matched -

	Salt	Degree of dissociation (α)	i
(A)	CaCl ₂	50 %	2
(B)	K ₄ [Fe(CN) ₆]	75%	4.5
(C)	[Ag(NH ₃) ₂]Cl	60 %	1.2
(D)	KCl	90 %	2.8

CLQ055

SECTION-II

- This section contains **THREE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4, if only (all) the correct option(s) is (are) chosen.

Partial Marks : +3, if all the four options are correct but **ONLY** three options are chosen.

Partial Marks : +2, if three or more options are correct but **ONLY** two options are chosen, both of which are correct options.

Partial Marks : +1, if two or more options are correct but **ONLY** one option is chosen and it is a correct option.

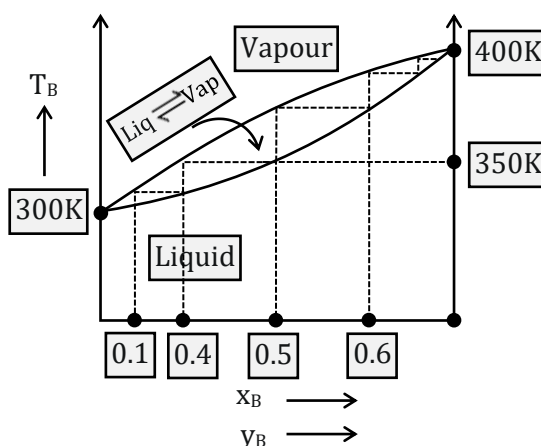
Zero Marks : 0, if none of the options is chosen (i.e. the question is unanswered).

Negative Marks : -2 in all other cases.

6. 1.22 gm $\text{C}_6\text{H}_5\text{COOH}$ is added into 100 gm of acetone, elevation in B.P. is found to be 0.17. If K_b (acetone) = $1.7 \text{ K} \cdot \text{Kg mol}^{-1}$ then select the incorrect options
- (A) Observed molar mass of benzoic acid is 61 gm/mole.
 (B) Observed molar mass of benzoic acid is 122 gm/mole
 (C) Benzoic acid behaves like a normal electrolyte
 (D) Benzoic acid exist as dimer in acetone due to intermolecular H-bonding

CLQ056

7. For an ideal solution having two liquid A (P_A^0) and liquid B (P_B^0) boiling point versus composition graph is given below, then select correct statement (s) :



- (A) B is less volatile than A
 (B) If mole percent of A in liquid phase is 40% then mole percent of A in vapour phase is 50%
 (C) If mole percent of B in liquid phase is 10% then mole percent of B in vapour phase is 40%
 (D) If the mole percent of A in solution is 50% then its boiling point is 350K

CLQ057

8. Two solutions S_1 and S_2 containing 0.1M NaCl(aq.) and 0.08M BaCl₂(aq.) are separated by semipermeable membrane. Which among the following statement(s) is/are correct -

S_1 0.1 M NaCl	S_2 0.08 M BaCl ₂
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SPM

- (A) S_1 and S_2 are isotonic
 (B) S_1 is hypertonic and S_2 is hypotonic
 (C) S_1 is hypotonic and S_2 is hypertonic
 (D) Osmosis will take place to from S_1 to S_2

CLQ058

SECTION-III

- This section contains **THREE** questions.
- Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.

Zero Marks : 0, if none of the bubbles is darkened.

Negative Marks : -1 in all other cases

Table type question :

Column-I	Column-II	Column-III
(1) $C_6H_6 + C_6H_5-CH_3$	(a) $\Delta H = 0$	(P) $\Delta G = -ve$
(2) $CHCl_3 + CH_3COCH_3$	(b) $\Delta H = +ve$	(Q) Form minimum boiling azerotrope
(3) $CCl_4 + CH_3COCH_3$	(c) $\Delta H = -ve$	(R) Form maximum boiling azerotrope
(4) $C_2H_5OH + H_2O$	(d) $\Delta S = +ve$	(S) No azeotrope

9. Select the correct match -

- (A) 1, a, R (B) 2, b, P
 (C) 3, b, Q (D) 4, d, R

CLQ059

10. Select the correct match -

- (A) 1, d, S (B) 3, b, S
 (C) 2, b, S (D) 4, c, P

CLQ060

11. Select the incorrect match -

- (A) 1, d, P (B) 2, c, R
 (C) 3, d, S (D) 3, b, P

CLQ061

SECTION-IV

- This section contains **ONE** paragraph.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to all the correct option.
- For each question, marks will be awarded in one of the following categories :
Full Marks : +4, if only (all) the correct option(s) is (are) chosen.
Zero Marks : 0, if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : -1 in all other cases.

Paragraph for Q. 12 - 13

2 moles of a volatile liquid (A) and 3 moles of another volatile liquid (B) are present in a solution at 25°C temperature in a closed container if vapour pressure of pure A and pure B at 25°C are $P_A^0 = 300$ torr, $P_B^0 = 200$ torr respectively (above solution follows Raoult's law of partial vapour pressure)

12. Calculate vapour pressure of distillate of the solution at 25°C temperature.
 (A) 250 torr (B) 240 torr (C) 280 torr (D) 270 torr

CLQ062

13. Which of the following is incorrect ?
 (A) Above solution form an Azeotropic mixture
 (B) Above solution can be separated by fractional distillation
 (C) Mole fraction of A in the 1st drop of vapour at 25°C is 0.5
 (D) Vapour of solution is 240 torr at 25°C

CLQ063

SECTION-V

- This section contains **SEVEN** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3, if **ONLY** the correct numerical value is entered as answer.
Zero Marks : 0 in all other cases.

14. How many grams of sucrose (mol.wt. = 342) should be dissolved in 100 gm water in order to produce a solution with 105°C difference between the freezing point & boiling point temperature at 1 atm?
 (Unit: $K_f = 2 \text{ K.kg mol}^{-1}$; $k_b = 0.5 \text{ K.kg mol}^{-1}$)

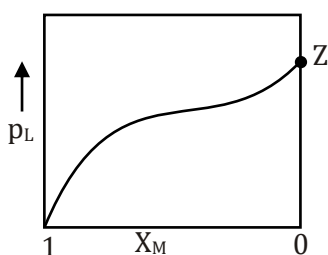
CLQ064

15. What should be the minimum pressure applied on 0.1 M glucose solution, filled in semi-permeable membrane, so as to filter away 750 mL water, leaving 250 mL of glucose solution at 300 K. (Report the answer as the closest integer value in atm after dividing by 2.)
CLQ065
16. When 0.1 M $\text{Pb}(\text{NO}_3)_2$ solution is titrated with 0.1 M KI solution then what will be the osmotic pressure (in atm) of solution when equivalence point is reached at 300 K.
(Take : $R = 0.08 \text{ atm L/mol-k}$)
CLQ066
17. Calculate the amount of ice that will separate out of cooling a solution containing 50g of ethylene glycol in 200 g water to -9.3°C . (K_f for water = $1.86 \text{ K mol}^{-1} \text{ kg}$)
CLQ067
18. 2 litre of 1 M MgCl_2 solution is mixed with 1 litre, 4 M AgNO_3 solution, then osmotic pressure in atm of final solution at 27°C will be.
($R = 0.082 \text{ litre atm/k-mole}$)
Reaction involved is $\text{MgCl}_2(\text{aq.}) + 2\text{AgNO}_3(\text{aq.}) \rightarrow \text{Mg}(\text{NO}_3)_2(\text{aq.}) + 2\text{AgCl}(\text{s})$
CLQ068
19. Normal boiling point of diethyl ether is 327° and at 190 mmHg boiling points in 27°C . What is the value of $\Delta H^\circ_{\text{vap}}$ in kJ/mole. (Use : $R = 8.3 \text{ J/K-mole}$, $\ln 2 = 0.7$).
CLQ069
20. Cane sugar undergoes the inversion as follows
$$\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{C}_6\text{H}_{12}\text{O}_6$$

If solution of 0.025 moles of sugar in 200 gm of water show depression in freezing point 0.372°C , then what % sucrose has inverted. ($K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}$)
CLQ070

Exercise - IV (JEE Advanced PYQs)

1. The freezing point (in °C) of a solution containing 0.1 g of $K_3[Fe(CN)_6]$ (Mol. Wt. 329) in 100 g of water ($K_f = 1.86 \text{ K kg mol}^{-1}$) is - [JEE (Advanced) 2011]
 (A) -2.3×10^{-2} (B) -5.7×10^{-2} (C) -5.7×10^{-3} (D) -1.2×10^{-2} CLQ071
2. For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2°C. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take $K_b = 0.76 \text{ K kg mol}^{-1}$) [JEE (Advanced) 2012]
 (A) 724 (B) 740 (C) 736 (D) 718 CLQ072
3. Benzene and naphthalene form an ideal solution at room temperature. For this process, the true statement(s) is(are) [JEE (Advanced) 2013]
 (A) ΔG is positive (B) ΔS_{system} is positive (C) $\Delta S_{\text{surroundings}} = 0$ (D) $\Delta H = 0$ CLQ073
4. If the freezing point of a 0.01 molal aqueous solution of a cobalt (III) chloride-ammonia complex (which behaves as a strong electrolyte) is -0.0558°C , the number of chloride (s) in the coordination sphere of the complex is- [K_f of water = $1.86 \text{ K kg mol}^{-1}$] [JEE (Advanced) 2015]
CLQ074
5. Mixture(s) showing positive deviation from Raoult's law at 35°C is (are) [JEE (Advanced) 2016]
 (A) carbon tetrachloride + methanol (B) carbon disulphide + acetone
 (C) benzene + toluene (D) phenol + aniline CLQ075
6. For a solution formed by mixing liquids L and M, the vapour pressure of L plotted against the mole fraction of M in solution is shown in the following figure, here X_L and X_M represent mole fractions of L and M, respectively, in the solution. the correct statement(s) applicable to this system is(are) [JEE (Advanced) 2017]



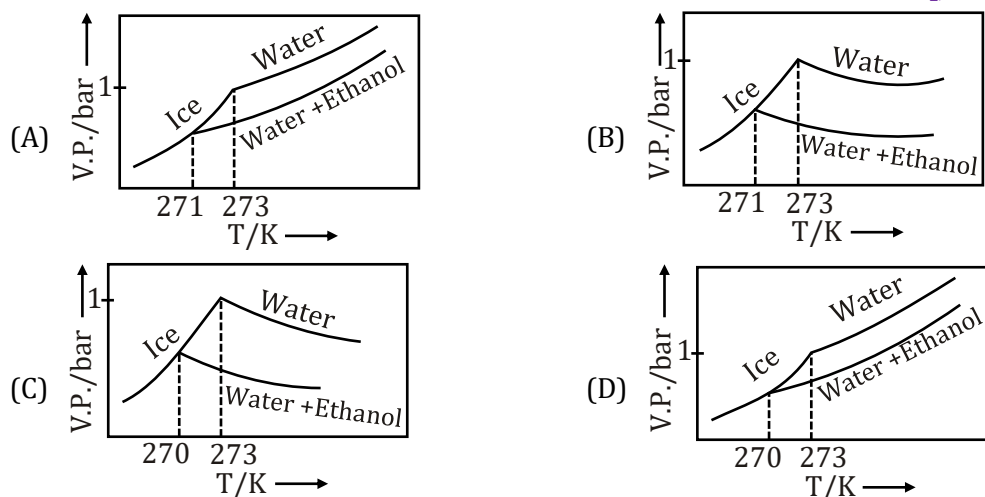
- (A) Attractive intramolecular interactions between L-L in pure liquid L and M-M in pure liquid M are stronger than those between L-M when mixed in solution
- (B) The point Z represents vapour pressure of pure liquid M and Raoult's law is obeyed when $X_L \rightarrow 0$
- (C) The point Z represents vapour pressure of pure liquid L and Raoult's law is obeyed when $X_L \rightarrow 1$
- (D) The point Z represents vapour pressure of pure liquid M and Raoult's law is obeyed from $X_L = 0$ to $X_L = 1$

CLQ076

7. Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1} . The figures shown below represents plots of vapour pressure (V.P.) versus temperature (T). [Molecular weight of ethanol is 46 g mol^{-1}]

Among the following, the option representing change in the freezing point is –

[JEE (Advanced) 2017]



CLQ077

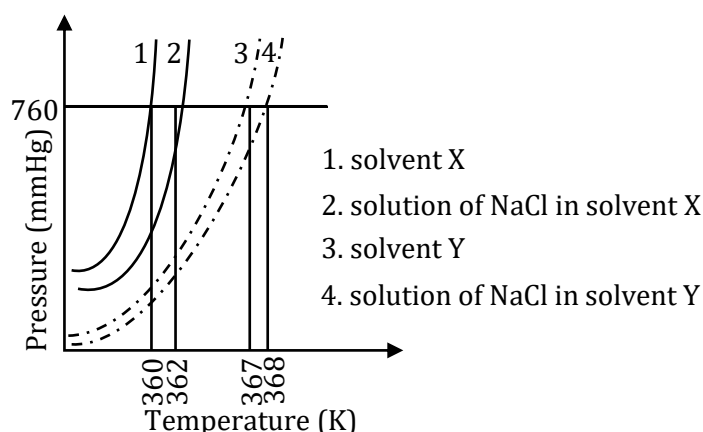
8. Liquids A and B form ideal solution over the entire range of composition. At temperature T, equimolar binary solution of liquids A and B has vapour pressure 45 Torr. At the same temperature, a new solution of A and B having mole fractions X_A and X_B , respectively, has vapour pressure of 22.5 Torr. The value of X_A/X_B in the new solution is ____.

(Given that the vapour pressure of pure liquid A is 20 Torr at temperature T)

[JEE (Advanced) 2018]

CLQ078

9. The plot given below shows P–T curves (where P is the pressure and T is the temperature) for two solvents X and Y and isomolal solutions of NaCl in these solvents. NaCl completely dissociates in both the solvents.



On addition of equal number of moles a non-volatile solute S in equal amount (in kg) of these solvents, the elevation of boiling point of solvent X is three times that of solvent Y. Solute S is known to undergo dimerization in these solvents. If the degree of dimerization is 0.7 in solvent Y, the degree of dimerization in solvent X is ____.

[JEE (Advanced) 2018]

CLQ079

10. On dissolving 0.5 g of a non-volatile non-ionic solute to 39 g of benzene, its vapor pressure decreases from 650 mm Hg to 640 mm Hg. The depression of freezing point of benzene (in K) upon addition of the solute is _____.
(Given data : Molar mass and the molal freezing point depression constant of benzene are 78 g mol^{-1} and $5.12 \text{ K kg mol}^{-1}$, respectively) [JEE (Advanced) 2019] CLQ080
11. Liquids **A** and **B** form ideal solution for all compositions of **A** and **B** at 25°C . Two such solutions with 0.25 and 0.50 mole fractions of **A** have the total vapor pressures of 0.3 and 0.4 bar, respectively. What is the vapor pressure of pure liquid **B** in bar? [JEE (Advanced) 2020] CLQ081

Question Nos. 12 and 13

The boiling point of water in a 0.1 molal silver nitrate solution (solution **A**) is $x^\circ\text{C}$. To this solution **A**, an equal volume of 0.1 molal aqueous barium chloride solution is added to make a new solution **B**. The difference in the boiling points of water in the two solutions **A** and **B** is $y \times 10^{-2}^\circ\text{C}$.

(Assume : Densities of the solutions **A** and **B** are the same as that of water and the soluble salts dissociate completely.)

Use: Molal elevation constant (Ebullioscopic Constant), $K_b = 0.5 \text{ K kg mol}^{-1}$; Boiling point of pure water as 100°C .)

12. The value of x is _____. [JEE (Advanced) 2021] CLQ082
13. The value of $|y|$ is _____. [JEE (Advanced) 2021] CLQ083
14. An aqueous solution is prepared by dissolving 0.1 mol of an ionic salt in 1.8 kg of water at 35°C . The salt remains 90% dissociated in the solution. The vapour pressure of the solution is 59.724 mm of Hg. Vapor pressure of water at 35°C is 60.000 mm of Hg. The number of ions present per formula unit of the ionic salt is _____. [JEE (Advanced) 2022] CLQ084
15. 50 mL of 0.2 molal urea solution (density = 1.012 g mL^{-1} at 300 K) is mixed with 250 mL of a solution containing 0.06 g of urea. Both the solutions were prepared in the same solvent. The osmotic pressure (in Torr) of the resulting solution at 300 K is ____.

[Use : Molar mass of urea = 60 g mol^{-1} ; gas constant, $R = 62 \text{ L Torr K}^{-1} \text{ mol}^{-1}$; Assume, $\Delta_{\text{mix}}H = 0$, $\Delta_{\text{mix}}V = 0$]

[JEE (Advanced) 2023] CLQ137

Answer Key

Exercise - I (JEE-Main Pattern)

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	2	3	4	3	4	2	2	1	2	3
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	2	1	2	3	2	3	2	2	2	4
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	0.25	65.25	40	3	3.00	6080.00	50	5.00	6.00	4.50

Exercise - II (JEE-Main PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	2	3	4	1	3	3	1	3	3	1.74 - 1.76
Question	11	12	13	14	15	16	17	18	19	20
Answer	177	167	600	518	13	3	1	314	116	4

Exercise - III (JEE-Advanced Pattern)

Section-I	Q.	1	2	3	4	5			
	A.	B	B	C	C	A			
Section-II	Q.	6	7	8					
	A.	A,D	A,B,D	C,D					
Section-III	Q.	9	10	11					
	A.	C	A	C					
Section-IV	Q.	12	13						
	A.	A	A						
Section-V	Q.	14	15	16	17	18	19	20	
	A.	68.4	5	3.2	38.71	49.20	6.97	60	

Exercise - IV (JEE-Advanced PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	A	A	BCD	1	AB	AC	D	19	0.05	1.02 or 1.03
Question	11	12	13	14	15					
Answer	0.20	100.10	2.50	5	682					

Important Notes