2.38 Column-I Column-II

Given : $K_{a1} = 5 \times 10^{-7}$, $K_{a2} = 5 \times 10^{-11}$ for H_2CO_3

$K_a(CH_3COOH) = 1.8 \times 10^{-5}$; $K_b(NH_4OH) = 1.8 \times 10^{-5}$

Column-I	Column-II
(A) $NaHCO_3$ (aq.)	(p) Significant cationic hydrolysis
(B) CH_3COONH_4 (aq.)	(q) Significant anionic hydrolysis
(C) $K_2SO_4.Al_2(SO_4)_3.24H_2O$ (aq.)	(r) Acidic (pH < 7)
(D) NaCN (aq)	(s) Basic (pH > 7)
	(t) pH is independent of concentration

2.39

Column- I	Column- II
(A) NH_4Cl in water	(p) Neutral solution which does not undergo hydrolysis
(B) CH_3COONa in water	(q) Cationic hydrolysis
(C) NH_4CN in water	(r) Anionic hydrolysis
(D) NaCl in water	(s) Both Cationic and Anionic hydrolysis

SECTION - VI : INTEGER TYPE

2.40 $[H^+]$ concentration in 0.01 M H_2O_2 solution ($K_{a_1} = 3 \times 10^{-12}$ and $K_{a_2} \approx 0$) is x M. Fill first two digits of 10^8 x as answer.

2.41 Solid BaF_2 is added to a solution containing 0.1 mole of sodium oxalate solution (1 litre) until equilibrium is reached. If the Ksp of BaF_2 and $BaC_2O_4(s)$ is 10^{-6} & 10^{-7} respectively. Assume addition of BaF_2 does not cause any change in volume and no hydrolysis of any of the cations or anions. (Given : $\sqrt{116} = 10.77$)

If concentration of Ba^{2+} ions in resulting solution at equilibrium is represented as 2.7×10^{-x}, then x is :

2.42 What is the ratio of moles of $Mg(OH)_2$ and $Al(OH)_3$ present in 1 lit saturated aqueous solution of $Mg(OH)_2$ & $Al(OH)_3$ (K_{SP} of $Mg(OH)_2 = 4 \times 10^{-12}$ and K_{SP} of $Al(OH)_3 = 1 \times 10^{-33}$). Give answer by multiplying by 10^{-16}.

2.43 When NaOH solution is gradually added to the solution of a weak acid (HA), the pH of the solution is found to be 5.0 at the addition of 10.0 mL of NaOH and 6.0 at the further addition of 10.0 mL of same NaOH. (Total volume of NaOH = 20 mL) calculate pK_a for HA [log 2 = 0.3]

[Fill your answer in the form of multiple of 10^{-1} for example if your answer is 2.1 then fill 21 as your answer]

2.44 Calculate the hydrogen ion concentration (in mol/dm³) in a solution containing 0.04 mole of acetic acid and 0.05 mole of sodium acetate in 500 mL of solution. Dissociation constant for acetic acid is 1.75×10^{-5}. Report your answer after multiplying by 2×10^6.

TOPIC 3 SOLUTIONS AND COLLIGATIVE PROPERTIES

SECTION - I : STRAIGHT OBJECTIVE TYPE

3.1 The vapour pressure of the solution of two liquids A(p^o = 80 mm) and B(p^o = 120 mm) is found to be 100 mm when x_A = 0.4. The result shows that :
(A) Solution exhibits ideal behaviour.
(B) Solution shows positive deviation.
(C) Solution shows negative deviation.
(D) Solution will show positive deviation for lower concentration and negative deviation for higher concentrations.

3.2 Barium ions, CN^- and Co^{2+} form an ionic complex. If this complex is 75% ionised in aqueous solution with Vant Hoff factor (i) equal to four and paramagnetic moment is found to be 1.73 BM (due to spin only) then the hybridisation state of Co (II) in the complex will be :
(A) sp^3d (B) d^2sp^3 (C) sp^3d^2 (D) dsp^3

3.3 Osmotic pressure [in atm] of a 0.1 M solution of $K_4[Fe(CN)_6]$, which undergoes 50% dissociation, will be ________ at 27°C :
(A) 7.38 (B) 3.69 (C) 405.9 (D) none of these

3.4 In an ideal mixture of liquids A and B the mole fraction of A is 0.25. If the ratio of $P_A{}^0$ to $P_B{}^0$ is 7/3, how many repeated distillations would be required as a "minimum" to obtain a small quantity of distillate which has a mole fractionof A, better than 0.80?
(A) 4 (B) 2 (C) 3 (D) 5

3.5 How many m.moles of sucrose should be dissolved in 500 grams of water so as to get a solution which has a difference of 103.57°C between boiling point and freezing point ?
(K_f = 1.86 K Kg mol^{-1}, K_b = 0.52 K Kg mol^{-1})
(A) 500 m.moles (B) 900 m.moles (C) 750 m.moles (D) 650 m.moles

3.6 Which of the following has been arranged in order of decreasing freezing point?
(A) 0.05 M KNO_3 > 0.04 M $CaCl_2$ > 0.140 M sugar > 0.075 M $CuSO_4$
(B) 0.04 M $BaCl_2$ > 0.140 M sucrose > 0.075 M $CuSO_4$ > 0.05 M KNO_3
(C) 0.075 M $CuSO_4$ > 0.140 M sucrose > 0.04 M $BaCl_2$ > 0.05 M KNO_3
(D) 0.075 M $CuSO_4$ > 0.05 M $NaNO_3$ > 0.140 M sucrose > 0.04 M $BaCl_2$

3.7 A solution of x moles of sucrose in 100 grams of water freezes at –0.2°C. As ice separates the freezing point goes down to 0.25°C. How many grams of ice would have separated?
(A) 18 grams (B) 20 grams (C) 25 grams (D) 23 grams

3.8 A sample of air is saturated with benzene (vapour pressure = 100 mm Hg at 298 K) at 298K, 750mm Hg pressure. If it is isothermally compressed to one third of its initial volume, the final pressure of the system is
(A) 2250 torr (B) 2150 torr (C) 2050 torr (D) 1950 torr

3.9 Available solutions are 1L of 0.1 M NaCl and 2L of 0.2 M $CaCl_2$. Using <u>only these two solutions</u> what maximum volume of a solution can be prepared having $[Cl^-]$ = 0.34 M exactly. Both electrolytes are strong
(A) 2.5 L (B) 2.4 L (C) 2.3 L (D) None of these

3.10 Consider equimolal aqueous solutions of $NaHSO_4$ and NaCl with ΔT_b and $\Delta T'_b$ as their respective boiling point elevations. The value of $\underset{m\to 0}{\text{Lt}} \dfrac{\Delta T_b}{\Delta T'_b}$ will be :

(A) 1 (B) 1.5 (C) 3.5 (D) $\frac{2}{3}$

3.11 A solute'S' undergoes a reversible trimerization when dissolved in a certain solvent. The boiling point elevation of its 0.1 molal solution was found to be identical to the boiling point elevation in case of a 0.08 molal solution of a solute which neither undergoes association nor dissociation. To what percent had the solute 'S' undergone trimerization?

(A) 30% (B) 40% (C) 50% (D) 60%

3.12 For a solution of 0.849 g of mercurous chloride in 50 g of $HgCl_2(\ell)$ the freezing point depression is 1.24°C. K_f for $HgCl_2$ is 34.3. What is the state of mercurous chloride in $HgCl_2$? (Hg GAM 200, Cl 200 or Hg = 200, Cu GAM 35.5 or Cu = 35.5)

(A) as Hg_2Cl_2 molecules (B) as HgCl molecules
(C) as Hg^+ and Cl^- ions (D) as Hg_2^{2+} and Cl^- ions

3.13 **Consider the following statements and arrange in the order of true/false as given in the codes.**

S_1 : Vapour pressure is a colligative property.
S_2 : Freezing point of a solution is always lower than that of the pure solvent.
S_3 : Acetic acid undergoes association in benzene. The molar mass of acetic acid, determined by elevation of boiling point is always higher than its normal molar mass.
S_4 : Osmotic pressure measurements can be used for determination of molar mass of polymers.

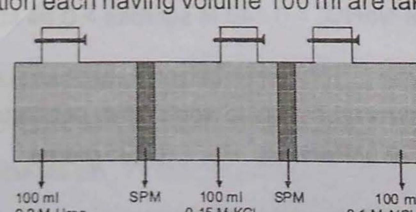
(A) FFFF (B) FTTT (C) TTTT (D) TFTF

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

3.14 The vapour pressure of two miscible liquids A and B are 300 and 500 mm of Hg respectively. In a flask, 2 moles of A are mixed with 6 moles of B. Further to the mixture, 32 g of an ionic non-volatile solute MCl (partially ionised, mol. mass = 70 u) were also added. Thus, the final vapour pressure of solution was found to be 420 mm of Hg. Then, identify the correct statement(s) : (Assume the liquid mixture of A and B to behave ideally).

(A) The numerical value of relative lowering in vapour pressure upon addition of solute MCl is 1/15.
(B) The solute MCl is 25% ionised in the above question.
(C) The solute MCl is 23.33% ionised in the above question.
(D) Upon addition of excess $Pb(NO_3)_2$, the number of moles of $PbCl_2$ precipitated is 2/35.

3.15 Consider the following system.
Three different aqueous solution each having volume 100 ml are taken and kept in contact as shown.



After sufficient time (Consider temp constant & 100% dissociation of strong electrolyte)

(A) Volume of urea solution will be $\frac{100}{3}$ ml.

(B) Volume of $AlCl_3$ solution will be $\frac{400}{3}$ ml.

(C) There will be no change in volume of KCl solution.

(D) Volume of both KCl and $AlCl_3$ solutions will increase.

3.16 2.25 g of a Non volatile substance dissolved in 250 g of C_6H_6 . This solution shows depression in F.P. by 0.256 K. Which of the following is /are correct :
Given that : (K_b and K_f for C_6H_6 is 2.53 Kmolal^{-1} and 5.12 Kmolal^{-1}, BP of C_6H_6 = 353.3 K)
(A) Molar mass of substance is = 180
(B) B.P. of solution is = 353.42 K
(C) Relative lowering in vapour pressure of solvent = 0.0038
(D) All are not correct

3.17 Which of following statements are incorrect about Henry's law ?
(A) It is applicable at all P as well as concentration
(B) It is applicable at all temperature
(C) Solubility of N_2, NH_3, O_2, HCl in water can be explained by Henry's law.
(D) Raoult's law is special case of Henry's law.

3.18 In which of the following pairs of solutions will the values of the vant Hoff factor be the same?
(A) 0.05 M $K_4[Fe(CN)_6]$ and 0.10 M $FeSO_4$
(B) 0.10 M $K_4[Fe(CN)_6]$ and 0.05 M $FeSO_4(NH_4)_2SO_4 . 6H_2O$
(C) 0.20 M NaCl and 0.10 M $BaCl_2$
(D) 0.05 M $FeSO_4(NH_4)_2SO_4 . 6H_2O$ and 0.02 M KCl . $MgCl_2 . 6H_2O$

3.19 Vapour pressure of solution containing 6g of a non-volatile solute in 180 g of water is 20.0 torr. If 1 mole water is further added vapour pressure increases by 0.02 torr. Which of the following is true ?
(A) The molecular weight of solute is 54g mol^{-1}
(B) The vapour pressure of pure water is 20.22 torr
(C) Addition of more water in the solution will further raise the vapour pressure of solution.
(D) The vapour pressure of pure water is 22.22 torr

3.20 Two liquids A and B form an ideal solution. The solution has a vapor pressure of 700 torr at 80°C. It is distilled till 2/3rd of the solution is collected as condensate. The composition of the condensate is $x'_A = 0.75$ and that of the residue is $x''_A = 0.30$. If the vapor pressure of the residue at 80°C is 600 Torr, which of the following is/ are true?
(A) The composition of the original liquid was $x_A = 0.6$.
(B) The composition of the original liquid was $x_A = 0.4$.
(C) $P_A^0 = \frac{2500}{3}$ Torr.
(D) $P_B^0 = 500$ Torr.

SECTION - III : ASSERTION AND REASON TYPE

3.21 **STATEMENT-1 :** Perfectly ideal solution is not possible with respect to binary solution of two liquids.
STATEMENT-2 : No two substances can have exactly the same nature of intermolecular forces & also of the same magnitude.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

3.22 **STATEMENT-1 :** When a cell is placed in hypertonic solution, it shrinks.
STATEMENT-2 : Reverse osmosis is used for desalination of water.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

3.23 **STATEMENT-1 :** The difference in the boiling points of equimolar solution of HCl and HF decreases as their molarity is decreased.
STATEMENT-2 : The extent of dissociation decreases steadily with increasing dilution.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

3.24 **STATEMENT-1 :** When 'a' mL of a 0.1 molal urea solution is mixed with another 'b' mL of 0.1 molal glucose solution, the boiling point of the solution is no different from the boiling points of the samples prior to mixing but if 'a' mL of 0.1 molal urea is mixed with 'b' mL of 0.1 molal HF, the boiling point of the mixture is different from the boiling points of the separate samples .
STATEMENT-2 : HF is an electrolyte (weak) whereas glucose is a non electrolyte.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

SECTION - IV : COMPREHENSION TYPE

Comprehension # 1

IDEAL SOLUTION AT FIXED TEMPERATURE

Consider two liquids 'B' and 'C' that form an ideal solution. We hold the temperature fixed at some value T that is above the freezing points of 'B' and 'C'. We shall plot the system's pressure P against x_B, the **overall mole fraction** of B in the system :

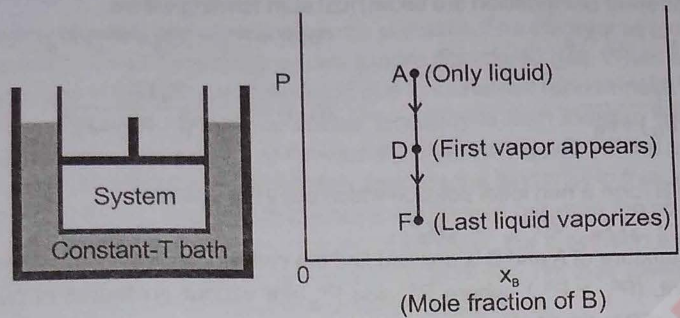
$$x_B = \frac{n_{B,total}}{n_{total}} = \frac{n_B^{\ell} + n_B^{v}}{n_B^{v} + n_C^{\ell} + n_C^{v} + n_B^{\ell}}$$

Where n_B^{ℓ} and n_B^{v} are the number of moles of B in the liquid and vapor phases, respectively. For a closed system x_B is fixed, although n_B^{ℓ} and n_B^{v} may vary.

Let the system be enclosed in a cylinder fitted with a piston and immersed in a constant-temperature bath. To see what the P-versus–x_B phase diagram looks like, let us initially set the external pressure on the piston high enough for the system to be entirely liquid (point A in figure) As the pressure is lowered below that at A, the system eventually reaches a pressure where the liquid just begins to vaporizes (point D). At point D, the liquid has composition x_B^{ℓ} where x_B^{ℓ} at D is equal to the overall mole fraction x_B since only an infinitesimal amount of liquid has vapourized. What is the composition of the first vapour that comes off ? Raoult's law, $P_B \equiv x_B^{v} P_B^{0}$ relates the vapour-phase mole fractions to the liquid composition as follows :

$$x_B^{v} = \frac{x_B^{\ell} P_B^{0}}{P} \text{ and } x_C^{v} = \frac{x_C^{\ell} P_C^{0}}{P} \qquad \text{.................. (1)}$$

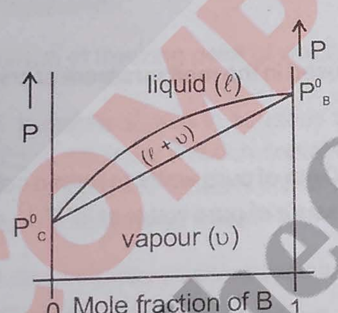
Where P_B^0 and P_C^0 are the vapour pressures of pure 'B' and pure 'C' at T, where the system's pressure P equals the sum $P_B + P_C$ of the partial pressures, where $x_B^{\ell} = \dfrac{n_B^{\ell}}{(n_B^{\ell} + n_C^{\ell})}$, and the vapor is assumed ideal.

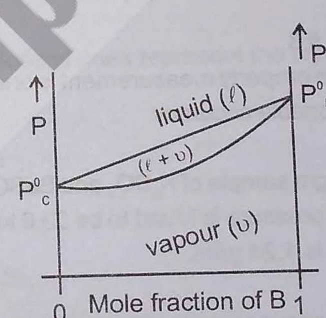


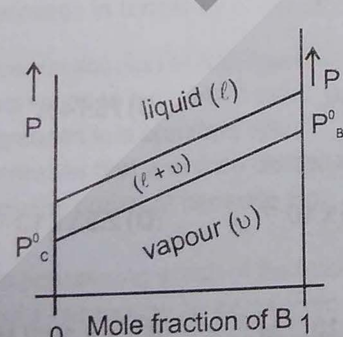
$$\frac{x_B^v}{x_C^v} = \frac{x_B^\ell P_B^*}{x_C^\ell P_C^*} \qquad \text{ideal solution} \qquad .... (2)$$

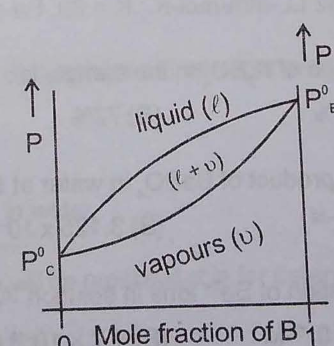
Let B be the more volatile component, meaning that $P_B^0 > P_C^0$. Above equation then shows that $x_B^v / x_C^v > x_B^\ell / x_C^\ell$. The vapor above an ideal solution is richer than the liquid in the more volatile component. Equations (1) and (2) apply at any pressure where liquid –vapor equilibrium exists, not just at point D. Now let us isothermally lower the pressure below point D, causing more liquid to vaporize. Eventually, we reach point F in figure, where the last drop of liquid vaporizes. Below F, we have only vapor. For any point on the line between D and F liquid and vapor phases coexist in equilibrium.

3.25 If the above process is repeated for all other compositions of mixture of C and B. If all the points where vapours start converting into liquid are connected and all the points where vapours get completely converted into liquid are connected then obtained graph will look like.

(A)


(B)


(C)


(D)


3.26 The equation of the curve obtained by connecting all those points where the vapors of above mixture (all mixtures of different composition are taken) just start forming will be

(A) $P = P^0_C + (P^0_B - P^0_C) X^{\ell}_B$

(B) $P = P^0_B + (P^0_B - P^0_C) X^{\ell}_B$

(C) $P = \dfrac{P^0_B P^0_C}{X^{v}_B(P^0_C - P^0_B) + P^0_B}$

(D) $P = \dfrac{P^0_B P^0_C}{X^{\ell}_B(P^0_C - P^0_B) + P^0_B}$

3.27 Two liquids A and B form a non ideal solution which obey the equation
$P_T = P^o_A + 3(P^o_B - P^o_A)\, x_B + 2(P^o_A - P^o_B)x_B^2$.
When equimolar mixture of A and B is distilled find the composition (by mole) when this mixture will have a single boiling point. ($P^o_B > P^o_A$) where P^o_A and P^o_B are vapour pressures of pure A and B respectively X_B = mole fraction of B in liquid phase :

(A) 3 : 1 (B) 2 : 3 (C) 1 : 2 (D) 1 : 3

Comperhension # 2

The pressure of two pure liquid A and B which form an ideal solutions are 400 mm Hg and 800 mm Hg respectively at temperature T. A liquid containing 3 : 1 molar composition pressure can be varied. The solutions is slowly vaporized at temperature T by decreasing the applied pressure starting with a pressure of 760 mm Hg. A pressure gauge (in mm) Hg is connected which given the reading of pressure applied.

3.28 The reading of pressure Gauge at which only liquid phase exists.

(A) 499 (B) 399 (C) 299 (D) None

3.29 The reading of pressure Gauge at bubble point is

(A) 500 (B) 600 (C) 700 (D) None

3.30 The reading of pressure Gauge at which only vapour phase exists is

(A) 501 (B) 457.14 (C) 425 (D) 525

Comprehension # 3

Colligative property measurement is one of the techniques used in the measurement of chemical quantities with reasonable accuracy.

If a 40.65 gm sample of K_2SO_4 and $BaSO_4$ is dissolved in 900 gm of pure water to form a solution 'A' at 57°C, its vapour pressure is found to be 39.6 torr while vapour pressure of pure water at 57°C is 40 torr. Density of solution A is 1.24 g/ml.

In a different experiment when small amount of pure $BaSO_4$ is mixed with water at 57°C it gives the osmotic rise of 4.05×10^{-5} atm.
(R = 0.082 Lt.-atm/mol-K ; K = 39, Ba = 137, S = 32, O = 16)

3.31 Percentage of K_2SO_4 in the sample is :

(A) 65.75% (B) 72% (C) 60.35% (D) 78.74%

3.32 Solubility product of $BaSO_4$ in water at 57°C is :

(A) 5×10^{-19} (B) 3.125×10^{-13} (C) 5.625×10^{-13} (D) 2.25×10^{-12}

3.33 Concentration of Ba^{2+} ions in solution 'A' is :

(A) 3.5×10^{-18} M (B) 4.7×10^{-15} M (C) 2.5×10^{-12} M (D) 4×10^{-13} M

3.34 Elevation in boiling point of solution A is (K_b water = 0.54 K-kg/mol) :

(A) 0.3 K (B) 0.1 K (C) 0.04 K (D) 0.05 K

Comprehension # 4

A system of greater disorder of molecules is more probable. The disorder of molecules is reflected by the entropy of the system. A liquid vaporises to form a more disordered gas. When a solute is present, there is additional contribution to the entropy of the liquid due to increased randomness. As the entropy of solution is higher than that of pure liquid, there is weaker tendency to form the gas. Thus, a solute (non volatile) lowers the vapour pressure of a liquid, and hence a higher boiling point of the solution.

Similarly, the greater randomness of the solution opposes the tendency to freeze. In consequence, a lower the temperature must be reached for achieving the equilibrium between the solid (frozen solvent) and the solution. Elevation of B.Pt. (ΔT_b) and depression of F.Pt. (ΔT_f) of a solution are the colligative properties which depend only on the concentration of particles of the solute, not their identity. For dilute solutions, ΔT_b and ΔT_f are proportional to the molality of the solute in the solution.

$\Delta T_b = K_b m$ K_b = Ebullioscopic constant = $\dfrac{RT_b^{o2} M}{1000\ \Delta H_{vap}}$

And $\Delta T_f = K_f m$ K_f = Cryoscopic constant = $\dfrac{RT_f^{o2} M}{1000\ \Delta H_{fus}}$ (M = molecular mass of the solvent)

The values of K_b and K_f do depend on the properties of the solvent. For liquids, $\dfrac{\Delta H_{vap}}{T_b^{\circ}}$ is almost constant.

[**Troutan's Rule**, this constant for most of the **unassociated liquids** (not having any strong bonding like Hydrogen bonding in the liquid state) is equal to 90 J/mol.]

For solutes undergoing change of molecular state is solution (ionization or association), the observed ΔT values differ from the calculated ones using the above relations. In such situations, the relationships are modified as $\Delta T_b = i\,K_b\,m$; $\Delta T_f = i\,K_f\,m$

where i = Van't-Hoff factor, greater than unity for ionization and smaller than unity for association of the solute molecules.

3.35 Depression of freezing point of which of the following solutions does represent the cryoscopic constant of water?
(A) 6% by mass of urea in aqueous solution
(B) 100g of aqueous solution containing 18 g of glucose
(C) 59 g of aqueous solution containing 9 g of glucose
(D) 1 M KCl solution in water.

3.36 Dissolution of a non-volatile solute into a liquid leads to the -
(A) decrease of entropy
(B) increase in tendency of the liquid to freeze
(C) increases in tendency to pass into the vapour phase.
(D) decrease in tendency of the liquid to freeze

3.37 To aqueous solution of NaI, increasing amounts of solid HgI_2 is added. The vapor pressure of the solution
(A) decreases to a constant value
(B) increases to a constant value
(C) increases first and then decreases
(D) remains constant because HgI_2 is sparingly soluble in water.

3.38 A liquid possessing which of the following characteristics will be most suitable for determining the molecular mass of a compound by cryoscopic measurements?
(A) That having low freezing point and small enthalpy of freezing
(B) That having high freezing point and small enthalpy of freezing
(C) That having high freezing point and small enthalpy of vaporisation
(D) That having large surface tension

3.39 A mixture of two immiscible liquids at a constant pressure of 1 atm boils at a temperature
(A) equal to the normal boiling point of more volatile liquid.
(B) equal to the mean of the normal boiling points of the two liquids.
(C) greater than the normal boiling point of either of the liquid.
(D) smaller than the normal boiling point of either of the liquid.

SECTION - V : MATRIX - MATCH TYPE

3.40

Column- I electrolyte	Column- II i (van't off factor)
(A) Urea, Glucose, Fructose	(p) 1 : 0.8 : 1
(B) NaCl, $MgCl_2$, K_2SO_4	(q) 1 : 2 : 3
(C) $Al_2(SO_4)_3$, Na_3PO_4, $K_4[Fe(CN)_6]$	(r) 1 : 1 : 1
(D) Glucose, NaCl, $CaCl_2$	(s) 2 : 3 : 3

3.41

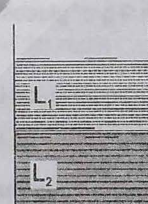
Column I	Column II
(A) Acetone + $CHCl_3$	(p) $\Delta S_{mix.} > 0$
(B) Ethanol + Water	(q) $\Delta V_{mix.} > 0$
(C) $C_2H_5Br + C_2H_5I$	(r) $\Delta H_{mix.} < 0$
(D) Acetone + Benzene	(s) Maximum boiling azeotropes
	(t) Minimum boiling azeotropes

3.42 Match the Column

Column-I	Column-II
(A) 0.1 M $Al_2(SO_4)_3$	(p) Solution with highest boiling point.
(B) 0.1 M $AlPO_4$	(q) Van't Hoff factor is greater than 1.
(C) 0.1 M urea.	(r) Solution with lowest osmotic pressure.
(D) 0.1 M $MgCl_2$	(s) Solution with lowest freezing point.

SECTION - VI : INTEGER TYPE

3.43 Two liquids 'A' (molecular mass = 40) and 'B' (Molecular mass = 20) are partially miscible. When 1 mol of A and 3 mol of B are shaken together and allowed to settle, two layer L_1 and L_2 are formed as shown in diagram. **(Mol)(P)[T]**



Layer 'L_1' contains 0.1 mole fraction of 'A' and layer 'L_2' contains 0.4 mole fraction of A calculate simple ratio of masses of layer L_1 to layer L_2. If your answer is $\frac{x}{y}$ then report as (x + y).

3.44 A solution of A (ℓ) and B (ℓ) with 30 mole percent of A is in equilibrium with its vapour which contains 60 mole percent of A. Assuming ideality of the solution and its vapour calculate the ratio of vapour pressure of pure A to that of pure B. (Report your answer as ratio × 2)

3.45 An ideal solution was prepared by dissolving some amount of can sugar (non-volatile) in 0.9 moles of water. The solution was then cooled just below its freezing temperature (271 K) where some ice get separated out. The remaining aqueous solution registered a vapour pressure of 700 torr at 373 K. Calculate the mass of ice separated out, if the the molar heat of fusion of water is 6 kJ.

3.46 If osmotic pressure of 1 M aqueous solution of H_2SO_4 at 500 K is 90.2 atm. Calculate Ka_2 of H_2SO_4. Give your answer after multiplying 10 with Ka_2. (Assuming ideal solution).
(Given : Ka_1 of H_2SO_4 is ∞, R = 0.082 lt-atm/mol-K).

3.47 2.56g of sulfur in 100g of CS_2 has depression in freezing point of 0.01°C. $K_f = 0.1$°molal^{-1}. Hence, the atomicity of sulfur in CS_2 is

3.48 0.0125 mol of sucrose is dissolved in 100 gm of water and it undergo partial inversion according to following equation

$$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

If elevation in boiling point of solution is 0.104°C calculate $\frac{1}{10}$ mol percentage of sugar inverted

($K_{b,\,H_2O} = 0.52$).

3.49 25 ml of FeC_2O_4 dissolved in 186 gm of water calculate depression in freezing point. If 10 ml of same FeC_2O_4 titrated with 30 ml of 0.4 M $KMnO_4$ in acidic medium (k_f for $H_2O = 1.86$, Assume 100% ionisation of FeC_2O_4).

3.50 In 10^3 Litre sample of hard water $CaSO_4$ and $MgSO_4$ is present. If elevation in Boiling point is 0.000052°C. Calculate the degree of Hardness of hard water. (K_b for $H_2O = 0.52$)

3.51 The vapour pressure of fluorobenzene at t°C is given by the equation

$$\log p\ (\text{mm Hg}) = 7.0 - \frac{1250}{t + 220}$$

Calculate the boiling point of the liquid in °C if the external (applied) pressure is 5.26% more than required for normal boiling point. (log 2 = 0.3)

3.52 1g of arsenic dissolved in 86 g of benzene brings down the freezing point to 5.31 °C from 5.50 °C. If K_f of benzene is 4.9 $\frac{°C}{m}$, the atomicity of the molecule is : (As = 75 or As GAM 75)

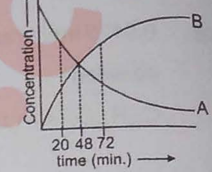
3.53 Assume liquefied petroleum gas (LPG) is a 50-50 (by mole) mixture of n-pentane and n-butane. Calculate the calorific value (in kJ/mol) of gas available from a newly filled cylinder.
Give your answer divide by 100.

	n-butane, C_4H_{10}	n-pentane, C_5H_{12}
Vapour pressure	1800 Torr	600 Torr
Calorific value	2800 kJ/mol	3600 kJ/mol

TOPIC 4 CHEMICAL KINETICS & RADIOACTIVITY

SECTION - I : STRAIGHT OBJECTIVE TYPE

4.1 For a first order reaction, $nA \rightarrow B$ whose concentration vs time curve is as shown in the figure. If half-life for this reaction is 24 minutes. Find out the value of n.



(A) 1
(B) 2
(C) 3
(D) 4

4.2 $^{24}_{11}Na$ (half-life = 15 hrs.) is known to contain some radioactive impurity (half-life = 3 hrs.) in a sample. This sample has an initial activity of 1000 counts per minute, and after 30 hrs it shows an activity of 200 counts per minute. What percent of the initial activity was due to the impurity ?

(A) 10 (B) 40 (C) 5 (D) 20

4.3 In a hypothetical reaction

$A(aq) \rightleftharpoons 2B(aq) + C(aq)$ (1^{st} order decomposition)

'A' is optically active (dextro-rototory) while 'B' and 'C' are optically inactive but 'B' takes part in a titration reaction (fast reaction) with H_2O_2. Hence the progress of reaction can be monitored by measuring rotation of plane of polarised light or by measuring volume of H_2O_2 consumed in titration.
In an experiment, the optical rotation was found to be $\theta = 30°$ at t = 20 min. and $\theta = 15°$ at t = 50 min. from start of the reaction. If the progress would have been monitored by titration method, volume of H_2O_2 consumed at t = 30 min. (from start) is 30 ml then volume of H_2O_2 consumed at t = 90 min. will be:

(A) 60 ml (B) 45 ml (C) 52.5 ml (D) 90 ml

4.4 At a certain temperature, the first order rate constant k_1 is found to be smaller than the second order rate constant k_2. If the energy of activation E_1 of the first order reaction is greater than energy of activation E_2 of the second order reaction, then with increase in temperature.

(A) k_1 will increase faster than k_2, but always will remain less than k_2
(B) k_2 will increase faster than k_1
(C) k_1 will increase faster than k_2 and becomes equal to k_2
(D) k_1 will increase faster k_2 and becomes greater than k_2

4.5 In the formation of HBr from H_2 & Br_2, following mechanism is observed.

(A) $Br_2 \rightleftharpoons 2Br\bullet$ Equilibrium step

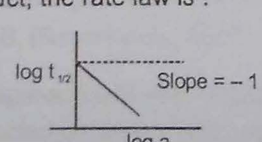
(B) $H_2 + Br\bullet \longrightarrow HBr + H\bullet$ Slow step

(C) $H\bullet + Br_2 \longrightarrow HBr + Br\bullet$ Fast step

Calculate the rate of reaction, if concentration of hydrogen is twice that of bromine and the rate constant is equal to one rutherford. Concentration of bromine is 1 M.

(A) 2×10^6 dps (B) 10×10^9 dps (C) $20 . 2 \times 10^{10}$ dps (D) 4×10^2 dps

4.6 A graph between log $t_{1/2}$ and log a (abscissa), a being the initial concentration of A in the reaction is given For reaction $A \rightarrow$ Product, the rate law is :



(A) $\frac{-d[A]}{dt} = K$ (B) $\frac{-d[A]}{dt} = K[A]$ (C) $\frac{-d[A]}{dt} = K[A]^2$ (D) $\frac{-d[A]}{dt} = K[A]^3$

4.7 In a gaseous phase reaction, $A_2(g) \longrightarrow B(g) + \frac{1}{2}C(g)$. The increase in pressure from 100 mm to 110 mm is observed in 5 minute. The rate of disappearance of A_2 in mm min^{-1} is :

(A) 4 (B) 8 (C) 16 (D) 2

4.8 For a 1st order reaction (gaseous) (constant V, T) :

$aA \longrightarrow (b-1)B + 1C$ (with b > a) the pressure of the system rose by $50\left(\frac{b}{a}-1\right)$ % in a time of 10 min. The half life of the reaction is therefore.

(A) 10 min (B) 20 min (C) 30 min (D) 40 min.

4.9 For a certain reaction the variation of the rate constant with temperature is given by the equation

$\ln k_t = \ln k_0 + \frac{(\ln 3)t}{10}$ $(t \geq 0°C)$

The value of the temperature coefficient of the reaction is :

(A) 0.1 (B) 1.0 (C) 10 (D) 3

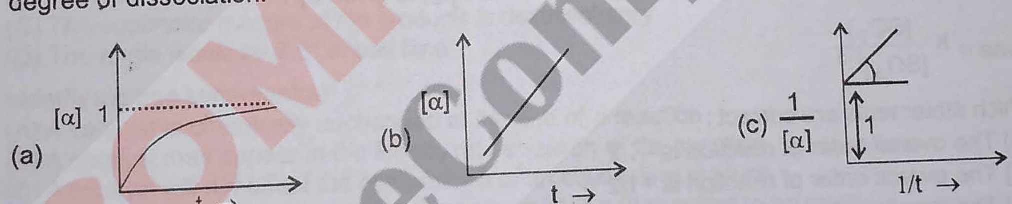
4.10 A reaction takes place in three steps ; the respective rate constants are k_1, k_2 and k_3. The overall rate constant $k = \frac{k_1k_3}{k_2}$. If energies of activation are 40 , 30 and 20 kJ, the overall energy of activation is (assumming 'A' to be constant for all) :

(A) 10 (B) 15 (C) 30 (D) 60

4.11 In a certain reaction, 10% of the reactant decomposes in one hour, 20 % in two hours, 30% in three hours and so on. The dimensions of the rate constant is :

(A) $hour^{-1}$ (B) mole $litre^{-1}$ sec^{-1} (C) litre $mole^{-1}$ sec^{-1} (D) mole sec^{-1}

4.12 Some graph are sketched for the reaction $A \rightarrow B$ (assuming different orders). Where 'α' represent the degree of dissociation.



The order of reaction are respectively.

(A) 0, 1, 2 (B) 1, 0, 2 (C) 2, 0, 1 (D) 1, 2, 0

4.13 Compounds A and B react with a common reagent with first order kinetics in both cases. If 99% of A must react before 1% of B has reacted, what is the minimum ratio for their respective rate constants?

(A) 916 (B) 229 (C) 500 (D) 458

4.14 The activity per ml of a solution of radioactive substance is x. How much water be added to 200 ml of this solution so that the acitivity falls to x/20 per ml after 4 half-lives ?

(A) 100 ml (B) 150 ml (C) 80 ml (D) 50 ml.

4.15 A reaction with respect to X is zero order till the concentration is reduced to half of initial concentration. Then the reaction become first order with respect to it. if the value of rate constants for the zero order and first order are equal to k (in magnitude), then find the time taken to reduce the concentration of X to $\frac{1}{16}$ th of its original concentration X_0.

(A) $\frac{1}{2k} + \frac{3\ell n2}{k}$ (B) $\frac{x_0}{2k} + \frac{3\ell n2}{k}$ (C) $\frac{x_0}{2k} + \frac{4\ell n2}{k}$ (D) $\frac{1}{2k} + \frac{4\ell n2}{k}$

4.16 For the decomposition of H_2O_2(aq) it was found that V_{O_2} (t = 15 min.) was 100 mL (at 0°C and 1 atm) while V_{O_2} (maximum) was 200 mL (at 0°C and 2 atm). If the same reaction had been followed by the titration method and if $V^{(cM)}_{KMnO_4}$ (t = 0) had been 40 mL, what would $V^{(cM)}_{KMnO_4}$ (t = 15 min) have been ?

(A) 30 mL (B) 25 mL (C) 20 mL (D) 15 mL

4.17 A reaction can take place by two paths. k_1 and k_2 are rate constants for the two paths & E_1 and E_2 are their respective activation energies.
At temperature T_a : $k_1 > k_2$, $E_1 < E_2$.
if temperature is raised to T_b, the rate constants change to k_1' & k_2'. Which relation is correct between k_1, k_2, k_1' & k_2' (considering activation energy does not change with temperature).

(A) $\frac{k_1'}{k_1} > \frac{k_2'}{k_2}$ (B) $\frac{k_1'}{k_1} = \frac{k_2'}{k_2}$ (C) $\frac{k_1'}{k_1} < \frac{k_2'}{k_2}$ (D) $\frac{k_1'}{k_2'} > \frac{k_1}{k_2}$

4.18 **Consider the following statements and arrange in the order of true/false as given in the codes.**

S_1 : The rate of the reaction A → B having the rate law $-\frac{d[A]}{dt} = k\,[A]\,[B]$ when plotted against time will exhibit a maximum at some time.
S_2 : A catalyst in a chemical reaction increases the forward E_a and decreases the backward E_a
S_3 : A catalyst in a chemical reaction decreases both forward and backward E_a
S_4 : For a first–order reaction, the time required to reduce successively the concentration of reactant by a constant fraction is always same.

(A) TTTT (B) FFFF (C) FTFT (D) TFTT

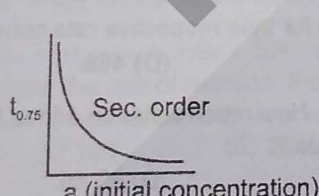
SECTION - II : MULTIPLE CORRECT ANSWER TYPE

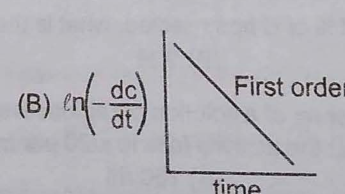
4.19 If the rate of reaction, $2SO_2(g) + O_2(g) \xrightarrow{Pt} 2SO_3(g)$ is given by :

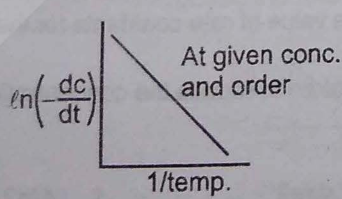
$$\text{Rate} = K\frac{[SO_2]}{[SO_3]^{1/2}}$$

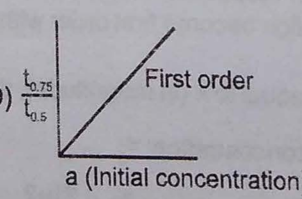
which statements are correct :
(A) The overall order of reaction is –1/2
(B) The overall order of reaction is +1/2
(C) The reaction slows down as the product SO_3 is build up
(D) The rate of reaction does not depend upon concentration of SO_3 formed

4.20 Which is correct graph :

(A) 

(B) 

(C) 

(D) 

4.21 For a certain reaction A $\longrightarrow$ products, the $t_{1/2}$ as a function of $[A]_0$ is given as below :

$[A]_0$ (M) :	0.1	0.025
$t_{1/2}$ (min.) :	100	50

Which of the following is true :

(A) The order is $\frac{1}{2}$ (B) $t_{1/2}$ would be $100\sqrt{10}$ min for $[A]_0 = 1$ M

(C) The order is 1 (D) $t_{1/2}$ would be 100 min for $[A]_0 = 1$ M

4.22* For the reaction 2A + B $\longrightarrow$ C with the rate law $\frac{d[C]}{dt} = k\,[A]^1\,[B]^{-1}$ and started with A and B in stoichiometric proportion. Which is/are true?

(A) unit of k is Ms^{-1} (B) [A], [B] and [C] all will be linear functions of time

(C) [C] = 2kt (D) [C] = kt

4.23 The reaction $2NO + Br_2 \longrightarrow 2NOBr$ follows the mechanism :

(1) $NO + Br_2 \underset{}{\overset{Fast}{\rightleftharpoons}} NOBr_2$

(2) $NOBr_2 + NO \xrightarrow{Slow} 2NOBr$

Which of the following is/are true regarding this :

(A) The order of the reaction with respect to NO is two.

(B) The molecularity of the steps (1) and (2) are two each.

(C) The molecularity of the overall reaction is three.

(D) The overall order of the reaction is three.

4.24 The polarimeter readings in an experiment to measure the rate of inversion of cane suger (1st order reaction) were as follows

time (min) :	0	30	∞
angle (degree) :	30	20	– 15

Identify the **true** statement (s) ? [log 2 = 0.3, log 3 = 0.48, log 7 = 0.84 , $\log_e 10 = 2.3$]

(A) The half life of the reaction is 75 min

(B) The solution is optically inactive at 120 min.

(C) The equimolar mixture of the products is dextrorotatory

(D) The angle would be 7.5° at half time

4.25 Identify the true statement(s)

(A) A catalyst is chemically unchanged at the end of a reaction

(B) A catalyst may appear in the kinetic rate equation of the reaction

(C) A catalyst will not affect the composition of an equilibrium mixture

(D) A catalyst cannot cause a non-spontaneous ($\Delta G > 0$) reaction to proceed

4.26 The half–period T for the decomposition of ammonia on tungsten wire, was measured for different initial pressures P of ammonia at 25°C. Then

P (mm Hg)	11	21	48	73	120
T (sec)	48	92	210	320	525

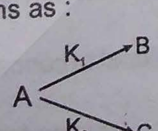
(A) Zero order reaction

(B) First order reaction

(C) Rate constant for reaction is 0.114 mol lit.$^{-1}$ sec^{-1}.

(D) Rate constant for reaction is 1.14 seconds.

4.27 The substance undergoes first order decomposition. The decomposition follows two parallel first order reactions as :



$K_1 = 10^{-2}$ sec^{-1} and $K_2 = 4 \times 10^{-2}$ sec^{-1}

If the corresponding activation energies of parallel reaction are 100 and 120 kJ mol^{-1} then the net activation energy of A is / are :

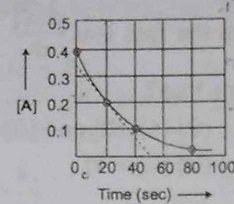
(A) 120 KJ mol^{-1} (B) 116 KJ mol^{-1} (C) 100 KJ mol^{-1} (D) 150 KJ mol^{-1}

4.28 A certain reaction obeys the rate equation (in the integrated form) $[C^{(1-n)} - C_0^{(1-n)}] = (n-1)\,kt$ where C_0 is the initial concentration and C is the concentration after time, t. Then :

(A) The unit of k for n = 1 is sec^{-1} (B) The unit of k for n = 2 is litre $mol^{-1}\ sec^{-1}$

(C) The unit of k for n = 3 is mol $litre^{-1}\ sec^{-1}$ (D) The unit of k for n = 3 is $litre^2\ mol^{-2}\ sec^{-1}$

4.29* A certain reaction $A \rightarrow B$ follows the given concentration (Molarity)–time graph. Which of the following statement(s) is/are true ?



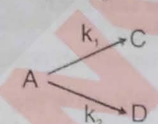
(A) The reaction is second order with respect to A

(B) The rate for this reaction at 20 second will be 7×10^{-3} M s^{-1}

(C) The rate for this reaction at 80 second will be 1.75×10^{-3} M s^{-1}

(D) The [B] will be 0.35 M at t = 60 second

4.30 Consider the following case of competing 1st order reactions.



After the start of the reaction at t = 0 with only A, the [C] is equal to the [D] at all times. The time in which all three concentrations will be equal is given by :

(A) $t = \dfrac{1}{2k_1}\ \ell n\,3$ (B) $t = \dfrac{1}{2k_2}\ \ell n 3$ (C) $t = \dfrac{1}{3k_1}\ \ell n 2$ (D) $t = \dfrac{1}{3k_2}\ \ell n 2$

4.31 Decomposition of $3A(g) \longrightarrow 2B(g) + 2C(g)$ follows first order kinetics. Initially only A is present in the container. Pressure developed after 20 min. and infinite time are 3.5 and 4 atm respectively. Which of the following is true.

(A) $t_{50\%} = 20$ min (B) $t_{75\%} = 40$ min (C) $t_{99\%} = 64/3$ min (D) $t_{87.5\%} = 60$ min

SECTION - III : ASSERTION AND REASON TYPE

4.32 **STATEMENT-1 :** If the activation energy of reaction is zero temperature, will have no effect on the rate constant.

STATEMENT-2 : Lower the activation energy faster is the reaction.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

4.33 **STATEMENT-1 :** For $A + 2B \longrightarrow C$ (rate= $K[A]^1[B]^0$), the half life time of reaction is only defined when concentration of A and B are in stoichometric ratio

STATEMENT-2 : For above reaction, half life of reaction is directly proportional to concentration of A and not to concentration of B due to its zero order.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

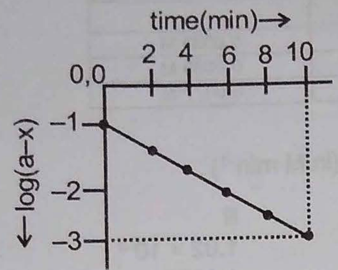
SECTION - IV : COMPREHENSION TYPE

Paragraph for Question Nos. 34 to 35

For I[st] order decomposition of $SO_2Cl_2(g)$,

$$SO_2Cl_2(g) \longrightarrow SO_2(g) + Cl_2(g)$$

a graph of log (a – x) v/s t is shown in figure



answer the following questions using above information.

4.34 What is the rate constant (in sec^{-1}) ?
(A) 0.2 (B) 4.6×10^{-1} (C) 7.7×10^{-3} (D) 1.15×10^{-2}

4.35 What is rate of reaction at t = 10 min [in mole/Lit./sec]
(A) 0.2×10^{-3} (B) 4.6×10^{-4} (C) 7.7×10^{-6} (D) 1.15×10^{-5}

Comperhension # 4

The rate law expresses the relationship of the rate of a reaction to the rate constant and the concentration of the reactants raised to some powers for the general reaction

$aA + bB \longrightarrow cC + dD$

Rate law takes the form

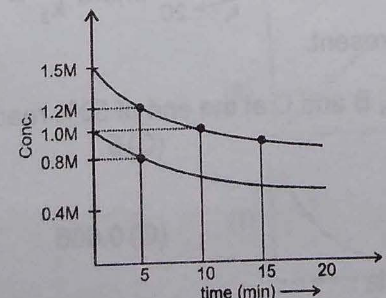
$r = k [A]^x [B]^y$

where x and y are number that must be determined experimentely k is the rate constant and [A] and [B] are concentration of A & B respectively.

4.36 Gaseous reaction A $\longrightarrow$ B + C follows first order kinetics concentration of A changes from 1M to 0.25 M in 138.6 min. Find the rate of reaction when conc. of A is 0.1 M.
(A) 10^{-2} M min^{-1} (B) 10^{-3} M min^{-1} (C) 10^{-4} M min^{-1} (D) 10^{-5} M min^{-1}

4.37 The initial rate of zero order reaction of the gaseous equation A (g) $\longrightarrow$ 2B (g) is 10^{-2} M min^{-1} if the initial concentration of A is 0.1 M what would be concentration of B after 60 seconds ?
(A) 0.09 M (B) 0.01 M (C) 0.02 M (D) 0.03 M

4.38 The variation of concentration of 'A' with time in two experiments starting with two different initial concentration of 'A' is given by the following graph. The reaction is represented by A (aq) $\longrightarrow$ B(aq) what is rate of reaction (M/min) when conc. of A in aqueous solution was 1.8 M :



(A) 0.072 M min^{-1} (B) 0.1296 M min^{-1}. (C) 0.036 M min^{-1} (D) 1 M min^{-1}

Comprehension

Study the following experiment and answer the questions at the end of it.

The following reactions was studied at 25°C in benzene solution containing 0.10 M pyridine

$$\underset{A}{CH_3OH} + \underset{B}{(C_6H_5)_3CCl} \longrightarrow \underset{C}{(C_6H_5)_3C.OCH_3} + HCl$$

The following sets of data were observed :

Set	Initial concentration		time difference	Final concentration [C]
	$[A]_0$	$[B]_0$		
I	0.10 M	0.05 M	25 min	0.0033 M
II	0.10 M	0.10 M	15 min	0.0039 M
III	0.20 M	0.10 M	7.5 min	0.0077 M

4.39 Rates $\frac{d[C]}{dt}$ in sets I, II and III are respectively (in M min^{-1}) :

	I	II	III
(A)	1.30×10^{-4}	2.6×10^{-4}	1.02×10^{-3}
(B)	0.033	0.0039	0.0077
(C)	0.02×10^{-4}	0.04×10^{-4}	0.017
(D)	None of above		

4.40 Rate law of the above experiment is :
(A) r = k [A] [B] (B) r = k $[A]^3$ [B] (C) r = k [A] $[B]^2$ (D) r = k $[A]^2$ $[B]^0$

4.41 Rate constant of the above experiment is :
(A) 1.3×10^{-1} (B) 2.6×10^{-2} (C) 2.6×10^{-1} (D) 1.3×10^{-2}

Comprehension # 4

From the following data answer the questions :

Reaction : A + B ⟶ P

[A] M	[B] M	Initial rate M sec^{-1}	
		300 K	400 K
2.5×10^{-4}	3.0×10^{-5}	5.0×10^{-4}	2.0×10^{-3}
5.0×10^{-4}	6.0×10^{-5}	4.0×10^{-3}	
1.0×10^{-3}	6.0×10^{-5}	1.6×10^{-2}	

4.42 The order w.r.t A is :
(A) 1 (B) 2 (C) 3 (D) – 1.

4.43 The value of rate constant at 300 K is (M^{-2} sec^{-1}) :
(A) 2.667×10^8 (B) 2.667×10^5 (C) 2.667×10^6 (D) 2.667×10^9

4.44 The energy of activation for reaction (KJ/mol) is :
(A) 20.83 (B) 13.83 (C) 15.23 (D) 10.23

Comprehension # 5

For a hypothetical elementary reaction $A \xrightarrow{k_1} 2B$, $A \xrightarrow{k_2} 2C$ where $\frac{k_1}{k_2} = \frac{1}{2}$

Initially only 2 moles of A are present.

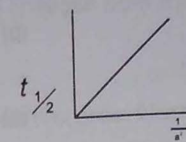
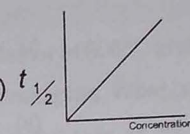
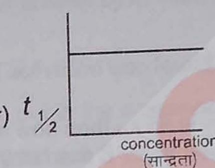
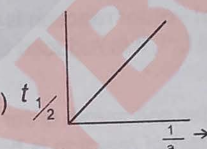
4.45 The total number of moles of A, B and C at the end of 50% reaction are :
(A) 2 (B) 3 (C) 5 (D) None

4.46 Number of moles of B are :
(A) 2 (B) 1 (C) 0.666 (D) 0.333

4.47 The sum of mole of (B) and (C) is :
(A) 2 (B) 3 (C) 1 (D) 4

SECTION - V : MATRIX - MATCH TYPE

4.48

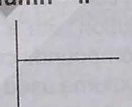
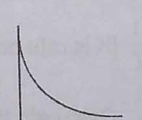
Column- I	Column- II
(A) Zero	(p) 
(B) First	(q) 
(C) Second	(r) 
(D) Third	(s) 

4.49 For A + B $\longrightarrow$ C in column - II the graphs given can be from any of these four types.

(a) $-\frac{dA}{dt}$ Vs time (x axis) (b) $t_{1/2}$ Vs initial conc. (x axis)

(c) $\left(\frac{C_0 - C_t}{C_t}\right)$ Vs time (x axis) (d) Conc. Vs time (x axis)

Match the graphs in Column–II for the given order of reactions in Column – I

Column – I	Column – II
(A) I[st] order	(p) 
(B) Zero order	(q) 
(C) Second order	(r) 
(D) Pseudo first order	(s) 
	(t)