தேசிய வெளிக்கள நிலையம் தொண்டைமானாறு
ஆறாம் தவணைப் பரீட்சை - 2024
National Field Work Centre, Thondaimanaru
6th Term Examination - 2024

| இரசாயனவியல் **Chemistry**	**Two Hours** Gr. 13 (2024)	**02**	**E**	**I**

01) Select the answer which represents the names of the scientists related to the following respectively,

I) The model for metallic bonding was proposed based on the kinetic model on the behavior of gases

II) Using mass spectrometer, discovered the isotopes from the deviations of charged particles in a magnetic field according to their e/m ratio.

(1) Niel Bohr, Aston

(2) Ludwig Drude, Aston

(3) J. J. Thomson, Niel Bohr

(4) Millikan, J. J. Thomson

(5) Hendrik Lorentz, de − Broglie

02) Electron pair geometry around the central atom of the species F_3BrO, $FBrO_3$ and F_4BrO^- are respectively,

(1) see-saw, tetrahedral, square pyramidal

(2) trigonal bipyramidal, tetrahedral, octahedral

(3) trigonal bipyramidal, tetrahedral, square pyramidal

(4) see-saw, tetrahedral, octahedral

(5) see-saw, trigonal pyramidal, octahedral

03) What is the IUPAC name of the following compound?

$$H - C \equiv C - \underset{\underset{CHO}{|}}{CH} - \overset{\overset{O}{||}}{C} - O - CH_3$$
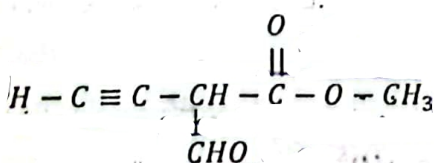
(1) methyl − 3 − formylbut − 1 − ynoate

(2) methyl 3 − formyl − 1 − butynoate

(3) methyl 2 − formylbut − 3 − ynoate

(4) methyl 2 − oxobut − 3 − ynoate

(5) methyl -2 − formylbut − 3 − ynoate

04) Which of the following statements is incorrect?

(1) Electron gain enthalpy of nitrogen is positive.

(2) Among the elements Be, C, Mg, Al and P, the one which has the highest electronegativity is C.

(3) OF_4 is the least stable one among the species OF_2, OF_4 and SF_4

(4) The electron represented by the quantum numbers (n, l, m_l, m_s) as $(4,0,0,+\frac{1}{2})$ has higher energy than the one having $(3,2,1,+\frac{1}{2})$

(5) Pauli exclusion principle states that an orbital cannot have more than 2 electrons.

05) A sample of CuO contains MnO_2 as the impurity. 4.35g of this sample was reacted with conc. HCl and the gas liberated was passed completely through an excess KI solution and the resulting solution was titrated against $5 \times 10^{-4} moldm^{-3}$ $Na_2S_2O_3$ solution. The burette reading was found to be $20cm^3$. Assuming that the volumes were measured under standard pressure and temperature, the composition of MnO_2 in ppm in the given sample $(Mn = 55, O = 16)$

(1) 10   (2) 100   (3) 175   (4) 1000   (5) 1750

06) The correct statement regarding benzene diazonium chloride,

(1) It is formed when aniline reacts with $NaNO_2/HCl$ at room temperature.

(2) When heated with water, it gives benzene as the product.

(3) When it reacts with $\beta - napthol$ in alkaline medium to form a red coloured dye, aryl diazonium ion acts as an electrophile.

(4) iodobenzene can be prepared by treating it with CuI

(5) All the reactions of it are electrophilic substitution reactions.

07) When the reaction $2A + B \rightarrow 2C$ occurs in the presence of a catalyst, the energy profile for the reaction mechanism is given below.
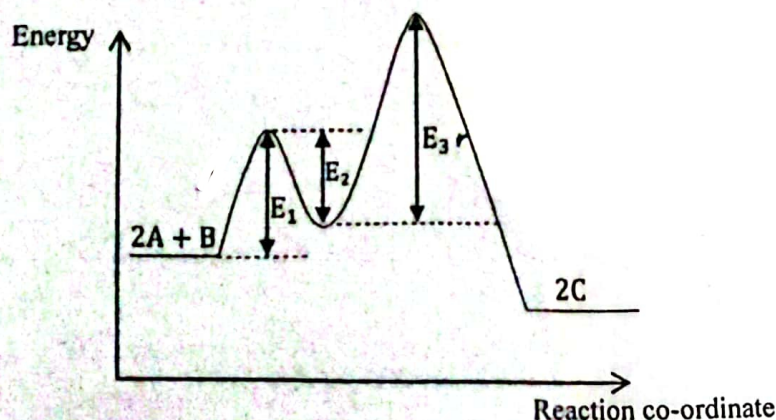
Which of the following statements regarding the above reaction is **incorrect**?

(1) The overall reaction is exothermic

(2) In the presence of the catalyst, the reaction mechanism consists of two steps

(3) If the first step of the mechanism in the presence of the catalyst is reversible, its forward reaction is endothermic.

(4) In the presence of the catalyst, the activation energy of the overall reaction is given by $E_1 + E_3$

(5) If the activation energy of the above reaction without a catalyst is E_a, then $E_a > E_1 + (E_3 - E_2)$

08) $CdO_{(s)} + H_{2(g)} \rightleftharpoons Cd_{(s)} + H_2O_{(g)}$; $\Delta H > 0$

The correct statement regarding the above equilibrium system,

(1) For the above system, the plot of $[H_{2(g)}]$ versus $[H_2O_{(g)}]$ is a straight line passing through the origin.

(2) When the volume of the system is increased, since both $[H_2O_{(g)}]$ and $[H_{2(g)}]$ will decrease by the same fraction rates of forward and reverse reactions will not change.

(3) The activation energy of the reverse reaction is less than that of the forward reaction

(4) Adding a small amount of anhydrous $CaCl_{2(s)}$ does not affect the equilibrium.

(5) The gradient of the graph drawn by plotting $[H_{2(g)}]$ in X axis and $[H_2O_{(g)}]$ in Y axis will decrease when the temperature is increased.

09) $X(OH)_3$ is a sparingly soluble ionic solid. At $25°C$, in a saturated solution of $X(OH)_3$ the concentration of X^{3+} ion is $1.6 \times 10^{-4} moldm^{-3}$ and the pH is 9. At the same temperature what will be the pH of the above solution if the concentration of X^{3+} ion is decreased to $2 \times 10^{-5} moldm^3$?
(At $25°C$, $K_w = 1 \times 10^{-14} mol^2 dm^{-6}$)

(1) 9.70   (2) 4.70   (3) 12.42   (4) 8.40   (5) 9.30

10) At $25°C$, $25cm^3$ of a given $0.1 moldm^{-3}$ acid solution was titrated with a base solution of concentration $0.2 moldm^{-3}$. The pH curve obtained during this titration is given on the right side. The point C represents the mid point of the portion AB.
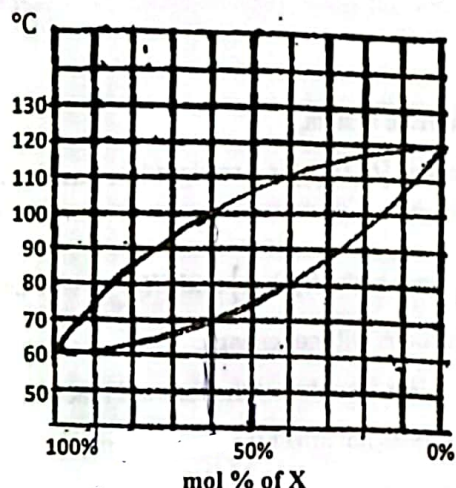
Which of the following statements is the most suitable one regarding the above titration?
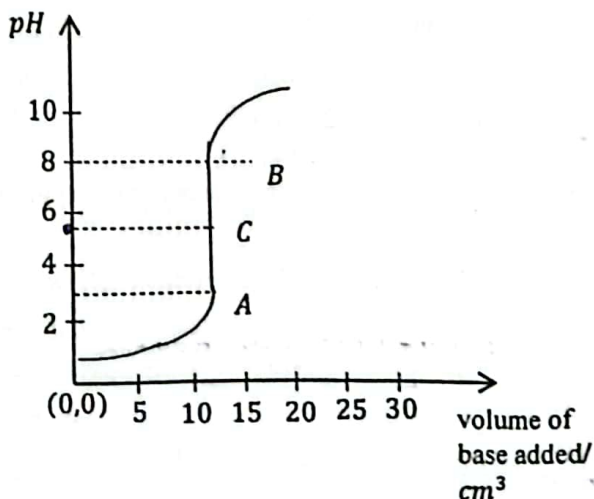
(1) The base used in this titration is a mono basic strong base.

(2) The given acid is a mono protic weak acid.

(3) An indicator having a colour change pH range 6.8 - 9 may be used in this titration.

(4) The given acid is a dibasic strong acid.

(5) The given acid is a mono basic strong acid and the base used is mono acidic weak base.

11) X and Y are two volatile liquids which can form an ideal solution. Given below is the temperature - composition phase diagram of a system containing X and Y under a pressure of $3.4 \times 10^5 \ Pa$

°C

130
120
110
100
90
80
70
60
50

100%   50%   0%

mol % of X

At 100°C, saturated vapour pressure of Y is

(1) $1.36 \times 10^5 \ Pa$ (2) $8.8 \times 10^5 \ Pa$ (3) $2 \times 10^5 \ Pa$

(4) $1.36 \times 10^6 \ Pa$ (5) $1.6 \times 10^5 \ Pa$

12) Which of the following statements is false with regard to C_2H_5MgBr?

(1) It reacts with CH_3COOH forming an alkane.

(2) The alkyl group in it can act both as an electrophile and a base.

(3) In the $C - Mg$ bond present in it, a partial negative charge is found in C

(4) The product of its reaction with CH_3COCl undergoes hydrolysis to give a tertiary alcohol.

(5) It reacts with $CH_3C \equiv CH$ to give $CH_3C \equiv CMgBr$ as one of the products.

13) $6.80g$ of pure $FeSO_3$ salt was dissolved in excess, dilute H_2SO_4. The whole solution was titrated with $0.5 moldm^{-3} \ KMnO_4$ solution. The required volume of $KMnO_4$ is ($Fe = 56, S = 32, O = 16$)

(1) $20cm^3$ (2) $30cm^3$ (3) $40cm^3$ (4) $50cm^3$ (5) $60cm^3$

14) Which of the following statements regarding group 17 elements and some of their compounds is correct?

(1) Bond dissociation energies of them follow the order $F_2 > Cl_2 > Br_2 > I_2$

(2) Boiling points of their hydrides increase in the order HF < HCl < HBr < HI

(3) Order of the oxidizing ability of the oxyacids of Cl is $HOCl > HClO_2 > HClO_3 > HClO_4$

(4) Compounds of Br with oxidation number $+7$ are stable at room temperature.

(5) Concentrated H_2SO_4 oxidizes Cl^-, Br^-, I^- as Cl_2, Br_2 and I_2 respectively.

15) Which one of the following statements is true with regard to Al and some of its compounds?

    (1) Al is the mo... abundant element found in the earth crust.

    (2) When $AlCl_3$ forms the stable state in gaseous state, the Cl atom in it acts as a Lewis acid.

    (3) $Al(OH)_3$ is formed due to the hydrolysis of $AlCl_3$

    (4) CO_2 gas is evolved when an aqueous solution of $Al(NO_3)_3$ is treated with $Na_2CO_{3(aq)}$

    (5) An aqueous solution of NH_3 can be used to distinguish between the aqueous solutions of $AlCl_3$ and $MgCl_2$

16) The incorrect statement regarding electrolysis,

    (1) The electrode connected to the positive terminal of the external electricity source in electrolysis is the anode

    (2) For the net reaction taking place during electrolysis, $\Delta G > 0$

    (3) During the electrolysis of $CuSO_4$ solution using Cu electrodes, O_2 gas is evolved at the anode.

    (4) When dilute $NaCl_{(aq)}$ is electrolyzed in alkaline medium using inert electrodes, OH^- ions are oxidized at the anode.

    (5) For an electrochemical cell, E^θ_{cell} is negative.

17) The incorrect statement regarding green-house gases is,

    (1) They should have the ability to absorb IR radiation and also to stay in the atmosphere for a long period of time.

    (2) NO and CO gases are not reckoned as greenhouse gases

    (3) Since halogenated hydrocarbons are present only in small quantities, they are not considered as greenhouse gases.

    (4) Mono atomic and homo diatomic gases are not capable of acting as greenhouse gases.

    (5) N_2O , one of the greenhouse gases, is mainly added to the atmosphere by the bacterial action of nitrogenous compounds.

18) The description of the products of the hydrolysis of three chlorides A, B and C are given below.

    A. A net work covalent sompound and a strong acid are obtained.

    B. A triprotic weak acid and a strong acid are obtained.

    C. A mono protic weak acid and a compound having basic nature.

    The compounds which are suitable to be A, B and C are respectively,

    (1) $SiCl_4$, NCl_3 , PCl_5 (2) PCl_3, NCl_3 , PCl_5 (3) $SiCl_4$, PCl_5, NCl_3

    (4) SCl_2 , PCl_5, NCl_3 (5) $AlCl_3$, NCl_3 , PCl_5

19) $Ba_3(PO_4)_2$ can be prepared by the following (unbalanced) chemical reaction.

$$BaCl_{2(aq)} + Na_3PO_{4(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + NaCl_{(aq)}$$
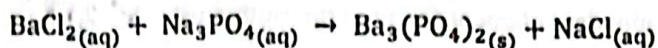
When 104g of $BaCl_2$ and 33.2g of Na_3PO_4 are reacted, 36.06g of $Ba_3(PO_4)_2$ was produced.

Under the above conditions, the limiting reagent and the percentage yield of $Ba_3(PO_4)_2$ are respectively,

[Molar masses : $BaCl_2 = 208 gmol^{-1}$, $Na_3PO_4 = 166 gmol^{-1}$, $Ba_3(PO_4)_2 = 601 gmol^{-1}$]

(1) $BaCl_2$, 50% (2) $BaCl_2$, 60% (3) $BaCl_2$, 75%

(4) Na_3PO_4. 50% (5) Na_3PO_4, 60%

20) Which of the following statements regarding some complex ions formed by 3d elements is **false**?

(1) Ni^{2+} and Cu^{2+} aqueous solution form deep blue solutions with excess $NH_{3(aq)}$.

(2) Aqueous solutions of Cu^{2+}, Ni^{2+} and Fe^{3+} produce yellow coloured complex ions with concentrated HCl.

(3) Mn^{2+} and Co^{2+} ions form blue coloured complexes with concentrated HCl

(4) Fe^{3+}, Cr^{3+} and Mn^{2+} form insoluble hydroxides with excess $NH_{3(aq)}$.

(5) When $NH_{3(aq)}$ is added in excess to $Co^{2+}_{(aq)}$, the yellow brown complex formed turns red brown when exposed to air.

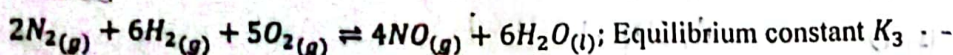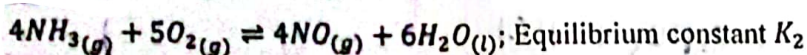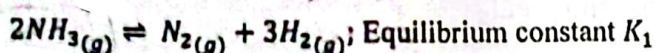21) The following elementary reaction takes place in a rigid container at constant temperature.

$$A_{(g)} \rightarrow 2B_{(g)} + C_{(g)}$$
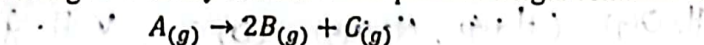
After two half-lives with regard to $A_{(g)}$, the pressure inside the system was found to be $7.5P$. What is the initial pressure of the system when there was only $A_{(g)}$ present in the system?

(1) $2P$ (2) $3P$ (3) $4P$ (4) $15P$ (5) $30P$

22) Which one of the following statements regarding some elements/ compounds in S block and P- block is **false**?

(1) Cs has the highest melting point among the elements of group 1

(2) Except $BeCO_3$, all the other group 2 carbonates do not dissolve in water.

(3) Due to its net-work covalent structure, B has the highest melting point among the elements which belong to its group.

(4) In the super oxide of K, (KO_2) oxygen is in the oxidation states of -1 and 0.

(5) Among group 17 elements, Cl has the highest negative electron gain enthalpy.

23) Consider the following three equilibrium reactions.

$2NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)}$; Equilibrium constant K_1

$4NH_{3(g)} + 5O_{2(g)} \rightleftharpoons 4NO_{(g)} + 6H_2O_{(l)}$; Equilibrium constant K_2

$2N_{2(g)} + 6H_{2(g)} + 5O_{2(g)} \rightleftharpoons 4NO_{(g)} + 6H_2O_{(l)}$; Equilibrium constant K_3

The correct relationship among K_1, K_2 and K_3

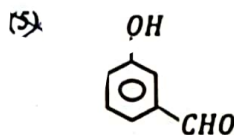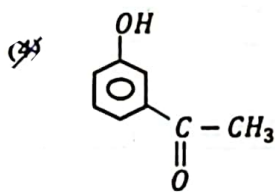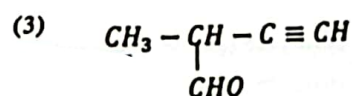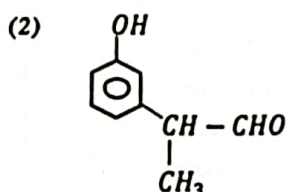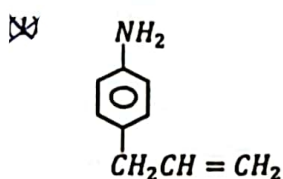(1) $K_3 K_1^2 = K_2$ (2) $K_3 = K_1^2 K_2$ (3) $K_3 K_2 = K_1^2$ (4) $K_1 K_2 = K_3$ (5) $K_3 K_1 = K_2$

24) The ascending order of the electronegativity of C atom in $CO_2, HCOOH, HCN$ and $HCHO$

(1) $HCOOH > HCHO > CO_2 > HCN$

(2) $HCOOH > CO_2 > HCHO > HCN$

(3) $HCN > HCHO > CO_2 > HCOOH$

(4) $CO_2 > HCN > HCOOH > HCHO$

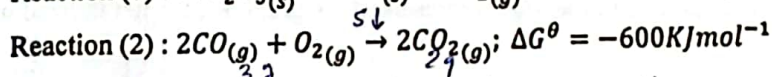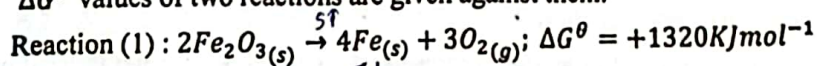(5) $HCN > CO_2 > HCHO > HCOOH$

25) The organic compound X gives the following observations.

- It forms silver mirror with Tollen's reagent.
- It decolorizes the orange colour of $Br_{2(aq)}$
- Does not give brick-red precipitate with Fehling's solution.

The compound X may be,

(1) NH_2 ... $CH_2CH = CH_2$ (benzene ring)

(2) OH ... $CH-CHO$ ... CH_3 (benzene ring)

(3) $CH_3 - CH - C \equiv CH$ with CHO

(4) OH ... $C-CH_3$ with $=O$ (benzene ring)

(5) OH ... CHO (benzene ring)

26) ΔG^{θ} values of two reactions are given against them.

Reaction (1) : $2Fe_2O_{3(s)} \rightarrow 4Fe_{(s)} + 3O_{2(g)}$; $\Delta G^{\theta} = +1320 KJmol^{-1}$

Reaction (2) : $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$; $\Delta G^{\theta} = -600 KJmol^{-1}$

The correct statement with regard to the above two reactions,

(1) Both reactions (1) and (2) take place with the increase in entropy.

(2) Reaction (2) is endothermic.

(3) For the reaction $Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$ $\Delta G^{\theta} = -240 KJmol^{-1}$

(4) Reaction (1) is exothermic

(5) For the reaction $Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$ $\Delta G^{\theta} = +240 KJmol^{-1}$

27) The incorrect statement regarding sulfur and some of its compounds,

(1) The reaction of sulfur with $NaOH_{(aq)}$ is a disproportination.

(2) Plastic sulfur and colloidal sulfur are two non-crystalline allotropes of sulfur.

(3) Since thiosulpuric acid is unstable at room temperature it decomposes as S, SO_2 and H_2O

(4) At temperature less than 95°C, rhombic sulfur converts to monoclinic sulfur.

(5) When molten sulfur is suddenly cooled by placing it in cold water, the crystalline form is converted to amorphoces.

28) The correct statement regarding the manufacture of caustic soda by membrane cell method,

   (1) In this process, during electrolysis, a selective membrane permits the migration of Na^+ ions from cathodic chamber to anodic chamber.

   (2) The purity of $NaOH$ produced by this method is very low ·

   (3) Ti anode and Ni cathode are used in this method.

   (4) $NaOH$ is produced in the anodic chamber.

   (5) During electrolysis, H_2 gas and Cl_2 gas are produced as the byproducts at the anode and cathode respectively.

29) A given NH_4OH solution has a mass percentage 30% and density $0.9 g cm^{-3}$. What volume of this solution must be taken to prepare $250 cm^3$ of $2 mol dm^{-3}$ NH_4OH solution

   (1) $64.2 cm^3$ (2) $190 cm^3$ (3) $204 cm^3$ (4) $220 cm^3$ (5) $267 cm^3$

30) The rate law for the reaction $A \rightarrow$ products is given by $R = K[A]^n$ where n is the rate order and K is the rate constant. In an experiment to determine n and K, $\log R$ was plotted against $\log[A]$ and the following graphs were obtained, The correct statement regarding the above graph,
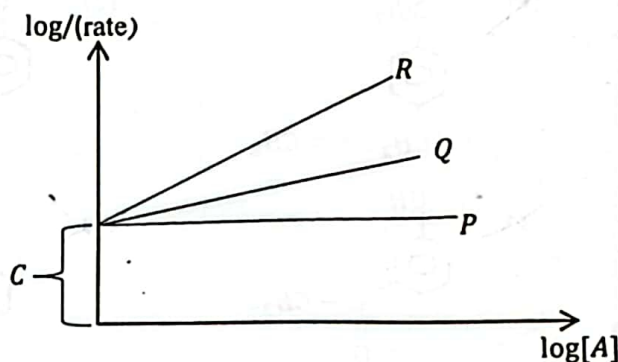
   (1) Rate constant K can be determined from the value of the intercept C of this graph.

   (2) The graph Q is relevant to zero order

   (3) The graph P corresponds to first order reaction.

   (4) Half - life of the reaction corresponding to the order represented by graph P does not depend on the initial concentration.

   (5) All the above are correct.

❖ **For the questions 31 – 40, use the following instructions.**

(1)	(2)	(3)	(4)	(5)
Only (a) and (b) are correct	Only (b) and (c) are correct	Only (c) and (d) are correct	Only (a) and (d) are correct	Any other combination.

31) Which of the following statements regarding a multi-step reaction is/are true?

   (a) Molecularity of the slowest step is equal to the order of the reaction.

   (b) Each single step of the reaction mechanism is considered as an elementary reaction.

   (c) Molecularity of each single step is greater than the overall order of the reaction.

   (d) Rate of the overall reaction depends on the slowest step.

32) The correct statement/ statements regarding H_2O_2 is/are,

   (a) H_2O_2 can act as an oxidizing agent and a reducing agent.

   (b) H_2O_2 is a polar and planar molecule.

   (c) Under standard conditions, boiling point of H_2O_2 is less than the boiling point of H_2O.

   (d) SO_2 is oxidized to H_2SO_4 in the reaction of SO_2 with H_2O_2.

33) The correct statement/ statements with regard to distillation processes is/are,

   (a) Fractional distillation can be used to separate the components of any liquid mixtures consisting of completely miscible liquids.

   (b) Both Dalton's law of partial pressures and Raoult's law are applicable to steam distillation process.

   (c) When successive vaporization - condensation processes are performed several times in fractional distillation process, the liquid having lower boiling point will be obtained ultimately.

   (d) In steam distillation, the mixture boils at a temperature less than the boiling points of each of the pure liquids under 1atm pressure.

34) Which of the following statements is/are true?

   (a) The colours of the aqueous solutions of MnO_4^- and CrO_4^{2-} ions are due to the electron transitions among degenerate d orbitals.

   (b) When $K_3[Fe(CN)_6]$ is added to a Fe^{2+} solution blue precipitate of $Fe_4[Fe(CN)_6]$ is obtained.

   (c) Although the electronegativity of the $3d$ elements in general increases from Sc to Zn, it shows decrease in Mn and Zn.

   (d) Among $3d$ elements, the elements having the highest and the lowest melting points are V and Zn respectively.

35) The correct statement/statements related to group 15 elements and some of their compounds is/are,

   (a) NCl_3 can ˙   ˙ed to disinfect water.

   (b) The eleme.. ..n this group which can form cations are precipitated in the same group in the qualitative analysis tests.

   (c) All the chlorides of the elements in this group undergo hydrolysis to give only acidic solutions.

   (d) The dipole moment of NF_3 is greater than the dipole moment of NH_3

36) Which of the following statements regarding half-life $\left(t_{\frac{1}{2}}\right)$ of a reaction is/are correct?

   (a) It always depends on the initial concentration of the reactant

   (b) For any order of the reaction, $t_{\frac{1}{2}}$ is inversely proportional to rate constant.

   (c) If the temperature is changed, $t_{\frac{1}{2}}$ will always change

   (d) For a zeroth order reaction, $t_{\frac{1}{2}}$ is directly proportional to the initial concentration.

37) The statement/ statements which is/are false regarding the reaction kinetics?

   (a) When the temperature increases, the percentage of higher energy collisions will also increase.

   (b) The activation energy of a slow reaction is less than that of a fast reaction.

   (c) Rate of the reaction increases when the concentration of any of the reactants is increased

   (d) Although a catalyst provides an alternative path for the reaction, the enthalpy change of the reaction is not affected by a catalyst.

38) Which of the statements regarding gases is/are true?

   (a) The pressure exerted by a real gas is greater than the pressure exerted by an ideal gas under same conditions.

   (b) Under high pressure conditions, if the temperature is increased, the compressibility factor Z approaches unity (1)

   (c) The compressibility factor of an ideal gas depends on the pressure.

   (d) The value of the compressibility factor Z can be given by the ratio between the respective molar volumes of a real gas and an ideal gas under conditions of same temperature and pressure.

39) The correct statement/ statements with regard to the reactions undergone by acid chlorides ($RCOCl$) with the reagents such as $NaOH$, NH_3 and H_2O

   (a) In all these reactions, in the first step, the carbon atom of the $\overset{O}{\underset{Cl}{\overset{\|}{C}}}$ group in acid chloride acts as a Lewis acid.

   (b) The first step in all the above reactions is nucleophilic addition

   (c) The order of the reactivity to act as a nucleophile follows the order $NH_3 > NaOH > H_2O$

   (d) Since addition followed by elimination takes place in the above reactions, overall reaction may be considered as nucleophilic substitution.

40) The solutions A and B are prepared by using pure , miscible liquids L, M, P and Q. The solution A is prepared by mixing L and M and the solution B is prepared by mixing P and Q. The boiling point-composition phase diagrams of A and B are given below..

solution A   solution B
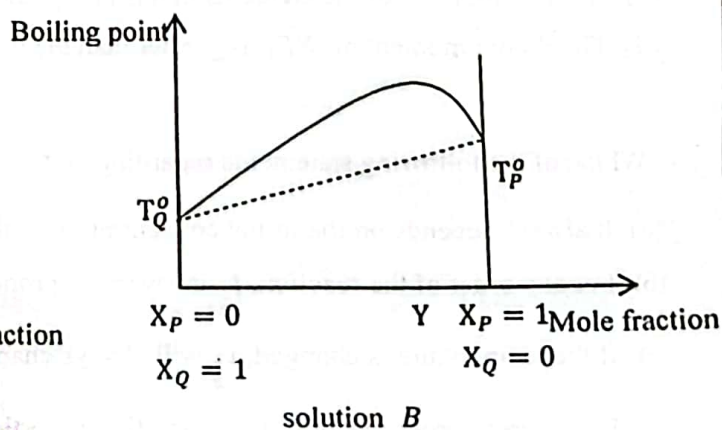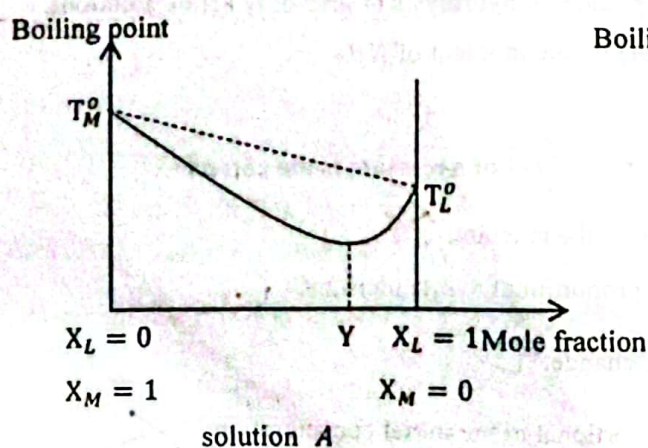
Which of the following is/are correct regarding the above graphs?

(a) The solution A shows negative deviation from Raoult's law and the solution B shows positive deviation.

(b) ΔH value for the formation of solution B is positive.

(c) Pure liquid P is less volatile than pure liquid Q.

(d) Among the mixtures formed by L and M, Y has the highest vapour pressure.

❖ **Instructions for questions 41 – 50.**

Response	First statement	Second statement
1)	True	True and correctly explains the first statement.
2)	True	True, but not explain the first statement correctly
3)	True	False
4)	False	True
5)	False	False

	Statement I	Statement II
41)	The boiling point of $1-propanol$ is greater than that of propanal.	Due to the $O-H$ group present in $1-propanol$, it forms $H-$bond with water whereas propanal does not form $H-$bond with wate
42)	When the compressibility factors of CO_2 and N_2 gases are less than one, $Z_{(CO_2)} < Z_{(N_2)}$ ($Z-$ compressibility factor)	When Z values of CO_2 and N_2 are less than one, attractive forces between CO_2 molecules are greater than these between N_2 molecules.
43)	When a solution containing Cu^{2+} and Ni^{2+} ions is treated with OH^-/H_2S, only Nis will be precipitated.	Since S^{2-} ion concentration is high in OH^-/H_2S, CuS will not be precipitated.
44)	The ability of the lone pair electrons in N atom of an amine to form a bond with H^+ is less than the ability of the lone pair electrons of the O atom of an alcohol.	Nitrogen is less electronegative than oxygen.
45)	Any ionic chloride salt which is insoluble in water does not dissolve in HCl also.	$Cl^-_{(aq)}$ is a conjugate base of a strong acid.
46)	A sparingly soluble salt which contains the anion of a weak acid dissolves when a strong acid solution is added.	Since K_a of a weak acid is small, the anion of the weak acid combines with any available H^+ to form a weak acid of less ionization.

47)	If the initial rate and the rate constant of a zeroth order reaction is R_o and k respectively, the rate of the reaction when the concentration decreases by 50% will be k.	In a zeroth order reaction, concentration of the reactant will remain unchanged with time.
48)	Bio diesel which is produced from bio methanol is 100% renewable.	Manufacture of biodiesel is a trans esterification process.
49)	In the reaction of $RCOOCH_3$ with an excess C_2H_5MgBr, the product is $RCOC_2H_5$.	$RCOOCH_3$ undergoes nucleophilic substitution in its reaction with Grignard reagent.
50)	In an electrochemical cell, the anions of the salt bridge move towards the electrode which has lower reduction potential.	Salt bridge maintains electrical neutrality and when using this, liquid junction potential is minimized.