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Royal College - Colombo

Royal College - Colombo 07

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Colombo 07 - Royal College

Third Term Test - November 2023

Grade 13

රසායන විද්‍යාව I
Chemistry I

02 E I

පැය දෙකයි
Two hours

name : Index No. : Grade :

- ❖ This paper consists of 10 pages.
- ❖ Answer all the questions.
- ❖ Use of calculators is not allowed.
- ❖ Write your Index Number in the space provided in the answer sheet.
- ❖ Follow the instructions given on the back of the answer sheet carefully.
- ❖ In each of the questions 1 to 30, pick one of the alternatives from (1), (2), (3), (4), (5) which is correct or most appropriate and mark your response on the answer sheet with a cross (X) in accordance with the instructions given on the back of the answer sheet.

Universal gas constant	R	=	8.314 J K ⁻¹ mol ⁻¹
Avogadro constant	N _A	=	6.022 x 10 ²³ mol ⁻¹
Planck's constant	h	=	6.626 x 10 ⁻³⁴ J s
Velocity of light	c	=	3 x 10 ⁸ m s ⁻¹

- Which one of the following is **incorrect** regarding the quantum numbers of an atom?
 - (1) To describe an orbital, the quantum numbers n , l and m_l are only used.
 - (2) When the value of n is high, the time spent by an electron away from its nucleus is greater.
 - (3) Azimuthal quantum number indicates the shape and size of an orbital.
 - (4) If the principal quantum number is n , the total number of orbitals of it is indicated by n^2 .
 - (5) m_l indicates the orientation of orbitals in three dimensional space.
- Which of the following does not show +2 oxidation number?

(1) Cr (2) Ni (3) Cu (4) Ti (5) Sc
- The correct ascending order of the second ionization energy is?

(1) O < F < Ne < Na (2) B < C < Be < Li (3) C < N < O < F
(4) Be < C < B < Li (5) N < O < F < C
- The shape and electron pair geometry of XeF₂ respectively are,
 - (1) Angular and Octahedral.
 - (2) Trigonal pyramidal and square planar.
 - (3) Linear and trigonal bipyramidal.
 - (4) Octahedral and square planar.
 - (5) See-saw and trigonal bipyramidal.
- In which of the following instances does both species are polar?

(1) XeF₄ and HCHO (2) PCl₅ and N₂O (3) COS and CH₃CHO
(4) XeF₄ and SiCl₄ (5) COS and CS₂

6. The valency and the oxidation number of Sulfur atom of $S_2O_8^{2-}$ ion respectively are,
 (1) 6 and + 7 (2) 4 and + 7 (3) 6 and + 6
 (4) 4 and + 6 (5) 6 and + 2
7. Out of the following oxides, an amphoteric oxide and a neutral oxide are respectively indicated by,
 (1) F_2O and MnO_2 (2) Cr_2O_3 and N_2O (3) Al_2O_3 and NO_2
 (4) CrO_3 and NO (5) SnO_2 and CO_2
8. IUPAC name of $Fe[Fe(CN)_5NO]$ is?
 (1) iron(II) pentacyanonitrosylferrate(II)
 (2) iron(III) pentacyanonitrosylferrate(II)
 (3) iron(II) nitrosylpentacyanidoferrate(III)
 (4) iron(III) pentacyanonitrosylferrate(III)
 (5) iron(II) pentacyanonitrosyliron(III)
9. What is the mass of solid $Fe(NO_3)_3$ that is required to prepare a 500.0 cm^3 solution with 200 ppm concentration of NO_3^- ions? (Fe - 56, N - 14, O - 16)
 (1) 130 mg (2) 156 mg (3) 260 mg (4) 200 mg (5) 500 mg
10. Which statement from the following is true regarding acyclic isomers that exist for the C_5H_9Br molecule?
 (1) Only shows diastereomerism.
 (2) Only shows enantiomerism.
 (3) Only shows chain isomerism.
 (4) Shows both diastereomerism and enantiomerism.
 (5) Only shows constitutional isomerism.
11. To a solid mixture containing 0.1 mol of Na_2SO_3 and an unknown amount of $Na_2S_2O_3$, HCl was added in excess. The gas evolved upon mixing was completely reacted with acidified $K_2Cr_2O_7$ solution with 1.0 mol dm^{-3} concentration. If the volume of $K_2Cr_2O_7$ used up was 42.0 cm^3 the mass of $Na_2S_2O_3$ in the mixture will be,
 (1) 4.108 g (2) 6.321 g (3) 3.163 g (4) 1.896 g (5) 1.580 g
12. Inside two closed vessels with volumes of V and 2V contain 0.28 g of N_2 and 0.32 g of SO_2 respectively. The temperatures of these two vessels are 27°C and 127°C respectively. The ratio between the pressures of the gases N_2 and SO_2 ($P_{N_2} : P_{SO_2}$) is, (N -14, S - 32, O -16)
 (1) 2 : 3 (2) 3 : 2 (3) 6 : 2 (4) 2 : 6 (5) 3 : 5

13. What is the standard Gibbs free energy change for the following reaction at 298 K?



Compound	$\Delta H_f^\circ / \text{kJ mol}^{-1}$	$\Delta S^\circ / \text{J K}^{-1} \text{mol}^{-1}$
CaO(s)	-1670.0	51.0
CaCl ₂ (aq)	-706.0	109.0
H ₂ O(l)	-286.0	70.0
HCl(aq)	-22.0	187.0

(1) - 648.6 kJ mol⁻¹ (2) - 619.5 kJ mol⁻¹ (3) 648.6 kJ mol⁻¹
 (4) 795.3 kJ mol⁻¹ (5) - 795.3 kJ mol⁻¹

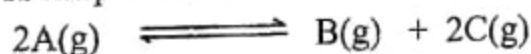
14. The standard electrode potentials of Pt(s) | I₂(s) | I⁻(aq) and Pt(s) | Cl₂(g) | Cl⁻(aq) electrodes are + 0.54 V and + 1.36 V respectively. Which statement from the following is true regarding the electrochemical cell formed by connecting these two electrodes together?

- (1) The cell reaction is $2\text{Cl}^-(\text{aq}) + \text{I}_2(\text{s}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{I}^-(\text{aq})$
 (2) The voltmeter reading is about 2.9 V.
 (3) When the cell is in operation, the chloride ion concentration decreases.
 (4) When the concentration of KI of the cell was increased the electromotive force increases.
 (5) The Cl₂(g) / Cl⁻(aq) electrode acts as the cathode and is the negative pole.

15. Which statement from the following is incorrect regarding the ozone molecule?

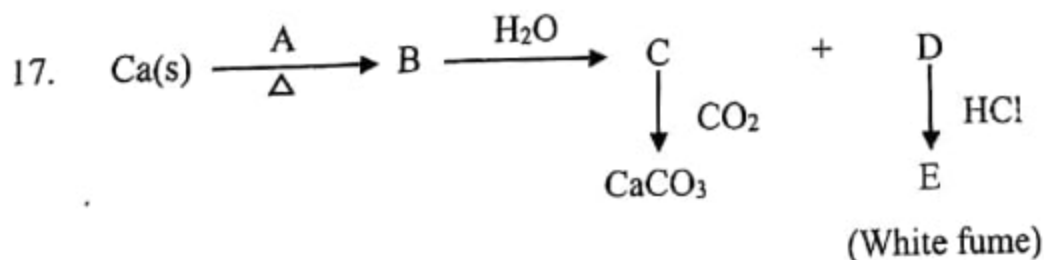
- (1) Shows resonance.
 (2) Involved in the prevention of ultraviolet rays from reaching the surface of the Earth.
 (3) Is non-polar.
 (4) The oxidizing ability is high compared to that of dioxygen.
 (5) Acts as a disinfectant.

16. 0.6 mol of gas "A" achieved the following state of equilibrium inside a closed rigid container at 600 K temperature.



At the same temperature of 600 K, a portion of gas B converts into its liquid state and establishes a liquid-vapor equilibrium. If the K_p value for the above reaction at 600 K temperature was 16×10^5 Pa and the saturated vapor pressure of B was 4×10^5 Pa at the same temperature, the remaining amount of moles of A in the equilibrium mixture is?

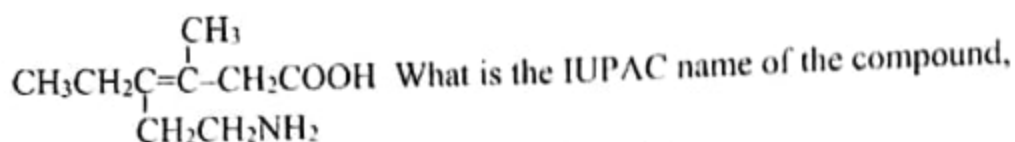
- (1) 0.4 (2) 0.2 (3) 0.3 (4) 0.1 (5) 0.5



What is **correct** regarding the flow diagram given above?

- (1) A is CO₂ (2) B is Ca₃N₂ (3) C is CaO
 (4) D is NH₄Cl (5) D is Ca(OH)₂

18.

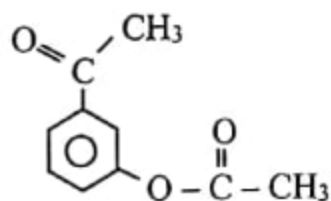


- (1) 6-amino-4-ethyl-3-methyl-3-hexenoic acid
- (2) 4-ethyl-3-methyl-6-aminohex-3-enoic acid
- (3) 4-ethyl-6-amino-3-methylhex-3-enoic acid
- (4) 1-amino-3-ethyl-4-methylhex-3-enoic acid
- (5) 6-amino-4-ethyl-3-methyl-3-hexanoic acid

19. A volume of $V \text{ cm}^3$ which was taken from an acid mixture containing 0.1 mol dm^{-3} concentration with respect to HCl and 0.5 mol dm^{-3} concentration with respect to CH_3COOH at 25°C was titrated with 0.1 mol dm^{-3} NaOH solution. Which one from the following expressions indicates the pH value of the first equivalence point? (The dissociation constant of CH_3COOH at 25°C is K_a)

- (1) $\text{p}K_a - \frac{1}{2} \log 0.5$
- (2) $\frac{1}{2} \text{p}K_a - \log 0.5$
- (3) $\log 0.25 + \text{p}K_a$
- (4) $\frac{1}{2} (\text{p}K_a - \log 0.5)$
- (5) $\frac{1}{2} \text{p}K_a + \log 0.05$

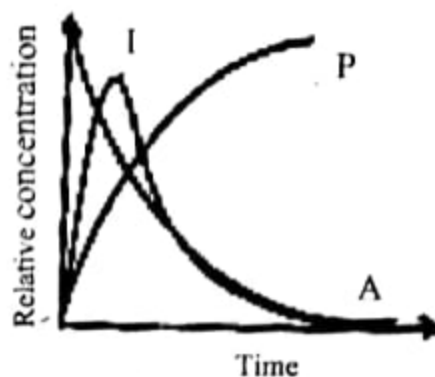
20.



When this organic compound was first reacted with CH_3MgBr in excess and secondly when dilute acid was added, what are the products formed at the end?

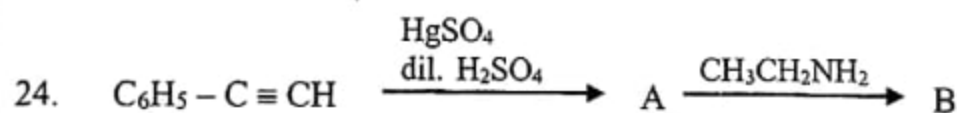
- 1) ,
- 2) ,
- 3) ,
- 4) ,
- 5) ,

21. In the reaction sequence $A \xrightarrow{K} I \rightarrow P$, the following graph indicates how the concentration of the species A, I and P varies with time .



Which statement of the following is incorrect about the given process?

- (1) The overall reaction is $A \rightarrow P$
 - (2) This is a multi-step reaction.
 - (3) At the beginning, first step occurs more slowly relative to the second step.
 - (4) The concentration of I reaches its maximum in a short period of time and then reaches zero.
 - (5) I is an Intermediate.
22. What is the OH^- ion concentration present in a 0.1 mol dm^{-3} solution of KF at 298 K? (The dissociation constant of HF at 298 K is $6.5 \times 10^{-4} \text{ mol dm}^{-3}$)
- (1) $1.6 \times 10^{-6} \text{ mol dm}^{-3}$
 - (2) $1.2 \times 10^{-6} \text{ mol dm}^{-3}$
 - (3) $2.6 \times 10^{-2} \text{ mol dm}^{-3}$
 - (4) $3.0 \times 10^{-12} \text{ mol dm}^{-3}$
 - (5) $1.5 \times 10^{-12} \text{ mol dm}^{-3}$
23. 12 g of Carbon completely reacts with O_2 to produce a mixture of CO and CO_2 gases. At 25°C temperature, the reaction releases 315 kJ of heat energy under constant pressure. If the standard enthalpies of formation for CO(g) and CO_2 (g) are -110 kJ mol^{-1} and -395 kJ mol^{-1} respectively, what is the mass of CO formed? (C – 12, O – 16)
- (1) 6.0 g
 - (2) 7.9 g
 - (3) 9.0 g
 - (4) 10.5 g
 - (5) 5.5 g



The compounds of A and B respectively are,

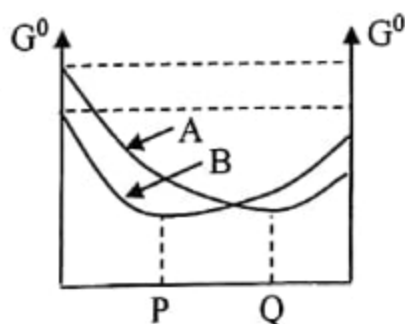
- 1) $\text{C}_6\text{H}_5 \text{COCH}_3$, $\text{C}_6\text{H}_5 - \overset{\text{OH}}{\underset{\text{CH}_2\text{CH}_3}{\text{C}}} - \text{CH}_2\text{CH}_3$,
- 2) $\text{C}_6\text{H}_5 \text{COCH}_3$, $\text{C}_6\text{H}_5 - \overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}} = \text{NCH}_2\text{CH}_3$
- 3) $\text{C}_6\text{H}_5 \text{CH}_2\text{CHO}$, $\text{C}_6\text{H}_5 - \overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}} = \text{NCH}_2\text{CH}_3$
- 4) $\text{C}_6\text{H}_5 \text{COCH}_3$, $\text{C}_6\text{H}_5 - \overset{\text{NH}_2}{\underset{\text{CH}_3}{\text{C}}} - \text{C}_2\text{H}_5$
- 5) $\text{C}_6\text{H}_5 \text{CH}_2\text{CHO}$, $\text{C}_6\text{H}_5\text{CH}_2\text{CH} = \text{NCH}_2\text{CH}_3$

25. The most stable product formed by the reaction between $\text{HOCH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} - \text{CH} = \underset{\text{CH}_3}{\text{C}} - \text{CH}_3$ and HBr will be,
- 1) $\text{Br} - \text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} - \text{CH} = \underset{\text{CH}_3}{\text{C}} - \text{CH}_3$ 2) $\text{HO} - \text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} - \underset{\text{Br}}{\text{CH}} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$
- 3) $\text{Br} - \text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} - \text{CHBr} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$ 4) $\text{Br} - \text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} - \text{CHBr} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$
- 5) $\text{Br} - \text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} - \text{CH}_2 - \underset{\text{Br}}{\overset{\text{CH}_3}{\text{C}}} - \text{CH}_3$
26. What is the solubility of Ag_2CrO_4 in a 0.1 mol dm^{-3} solution of AgNO_3 at 298 K? The solubility product coefficient of Ag_2CrO_4 at 298 K is $1.1 \times 10^{-12} \text{ mol}^3 \text{ dm}^{-9}$.
- (1) $1.1 \times 10^{-19} \text{ mol dm}^{-3}$ (2) $1.1 \times 10^{-11} \text{ mol dm}^{-3}$
 (3) $1.1 \times 10^{-12} \text{ mol dm}^{-3}$ (4) $1.1 \times 10^{-10} \text{ mol dm}^{-3}$
 (5) $1.1 \times 10^{-5} \text{ mol dm}^{-3}$
27. Which one from the following is correct regarding $\text{C}_6\text{H}_5\text{NH}_2$ (aniline)?
- (1) Is more basic than ammonia.
 (2) At high temperatures, by reacting with NaNO_2 and HCl forms diazonium ions.
 (3) The benzene ring of this has been deactivated.
 (4) In basic medium with phenol, forms a red coloured dye.
 (5) Forms a secondary amide with $\text{C}_6\text{H}_5\text{COCl}$.
28. Which one from the following is false regarding bromobenzene?
- (1) C – Br bond is relatively stronger than a single bond.
 (2) By reacting with NaOH produces phenol.
 (3) Gives benzene when Mg/dry ether was added followed by the addition of a dilute acid.
 (4) The phenyl cation formed by the removal of the bromine as Br^- is highly unstable.
 (5) Bromine group deactivates the benzene ring and is acting as an ortho/para director.
29. Two 25.0 cm^3 samples taken from a solution mixture containing KOH and NH_4OH are titrated with 0.2 mol dm^{-3} HCl solution in the presence of phenolphthalein and methyl orange indicators separately. The burette readings obtained were 10.0 cm^3 and 25.0 cm^3 respectively. The molar ratio between KOH and NH_4OH in the aqueous solution is,
- (1) 5 : 2 (2) 2 : 5 (3) 2 : 3 (4) 3 : 2 (5) 5 : 1
30. An electrolysis process was carried out by sending a 1.2 A current for a time period of one hour through a dil. H_2SO_4 acid solution using inert electrodes at 25°C temperature and $1 \times 10^5 \text{ Pa}$ pressure. The amount of moles of oxygen gas produced at the anode is,
- (1) 0.02 (2) 0.01 (3) 0.05 (4) 0.07 (5) 0.04

- For each of the following questions 31 to 40, one or more responses out of the four responses (a), (b), (c) and (d) given is/are correct. Select the correct response / responses. In accordance with the instructions given on your answer sheet, mark.

Summary of above instructions				
1	2	3	4	5
Only (a) and (b) correct	Only (b) and (c) correct	Only (c) and (d) correct	Only (d) and (a) correct	Any other response or combination of responses correct

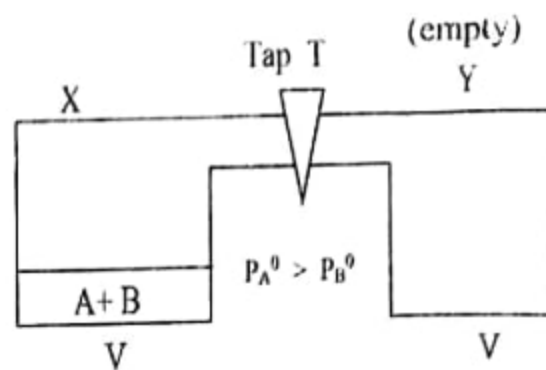
31. Which statement/s from the following is/are true regarding a clear solution containing only $\text{Ba}(\text{OH})_2$ and ZnCl_2 ?
- (a) A white precipitate forms when H_2S was bubbled through it.
- (b) During the addition of dil. HCl , initially gives a precipitate and when added in excess it dissolves.
- (c) When a solution of NH_4Cl was added, it releases NH_3 .
- (d) Gives an orange coloured precipitate when a $\text{K}_2\text{Cr}_2\text{O}_7$ solution was added.
32. Which reaction/s out of the following become/s spontaneous at low temperatures and is/are non-spontaneous at higher temperatures?
- a) $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{NO}_2(\text{g})$
- b) $\text{CaCO}_3(\text{s}) \longrightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- c) $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \longrightarrow \text{NH}_4\text{Cl}(\text{s})$
- d) $\text{SO}_2(\text{g}) + \text{Cl}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow \text{H}_2\text{SO}_4(\text{aq}) + 2\text{HCl}(\text{aq})$
33. To minimize the oxidation of Fe^{2+} ions to Fe^{3+} ions, which of the following strategy/strategies can be used?
- (a) Addition of Fe powder. (b) Addition of NaCl .
- (c) Addition of NH_4OH (d) Addition of KI .
34. The following graph indicates the variation of Gibbs free energy against the composition of reactants for the cell reactions of two given cells A and B.



Which statement/s from the following is/are true regarding the two cells A and B?

- (a) E°_{cell} of A > E°_{cell} of B.
- (b) At the compositions of P and Q, the cells A and B theoretically discharge them respectively.
- (c) As the rate of electrical discharge of cell B is greater, the current produced by B must be higher.
- (d) The efficiency of cell B is relatively high.

35. An ideal binary solution containing the liquids A and B is at equilibrium as indicated above (The tap T is closed at the beginning). At constant temperature, the tap T was opened and the system was allowed to reach the state of equilibrium again. When the system is at equilibrium for the second time the solution still remained. Which one/s from the following is/are true regarding the system at its state of equilibrium for the second time?



- (a) Mole fraction of A decreases at liquid phase.
- (b) The total pressure must be decreased in the gaseous phase.
- (c) The partial pressure of A increases in the gaseous phase.
- (d) Mole fraction of B increases in the gaseous phase.

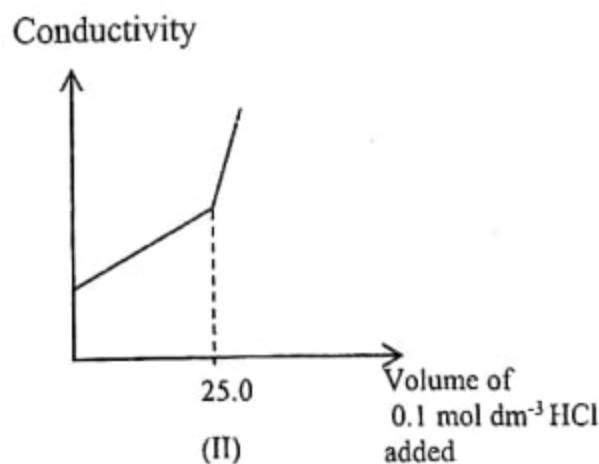
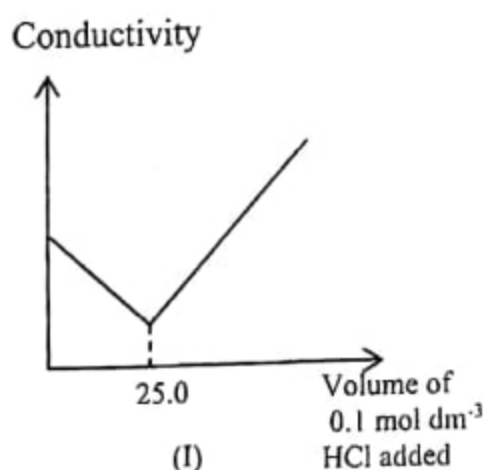
36. Which of the following **cannot** act as a buffer/buffers?

- (a) CH_3COOH in excess / NaOH
- (b) NaHCO_3
- (c) KHSO_4
- (d) $\text{C}_6\text{H}_5\text{NH}_2$ / $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$

37. Which statement/s from the following is/are true regarding polymers?

- (a) Teflon is a thermosetting polymer.
- (b) Nylon -6,6 is a thermoplastic polymer.
- (c) During the combustion of vulcanized rubber, it releases CO_2 and SO_2 gases.
- (d) Acids are used to prevent the coagulation of natural rubber latex.

38. The following graphs indicate the variation of the conductivity of the two solutions in the titrimetric flasks against the volume of the 0.1 mol dm^{-3} HCl acid solution added from the burette during two separate titrations carried out.



Which statement/s from the following is/are **true** regarding these graphs?

- (a) Graph (I) indicates the titration between 25.0 cm^3 of 0.1 mol dm^{-3} NaOH with HCl .
- (b) Graph (II) indicates the titration between 12.5 cm^3 of 0.1 mol dm^{-3} NaOH solution with HCl .
- (c) Graph (I) indicates the titration between 12.5 cm^3 of 0.1 mol dm^{-3} NH_4OH solution with HCl .
- (d) Graph (II) indicates the titration between 25.0 cm^3 of 0.1 mol dm^{-3} NH_4OH solution with HCl .

39. Which of the following statement/s is/are **false** regarding the formation of acid rain?
- Oxides of Sulfur and Nitrogen affects greatly on the formation of acid rain.
 - SO₂ gas released during volcanic eruptions is causing the formation of acid rain.
 - CO and CO₂ gases are involved in the formation of acid rain.
 - Since NO is a neutral oxide, it is not involved in the formation of acid rain.
40. During the Ostwald process of the formation of nitric acid,
- Ammonia is oxidized by the atmospheric oxygen.
 - The NO₂ which is formed is dissolved in acidulated water to produce nitric acid.
 - V₂O₅ is used as a catalyst.
 - Uses high temperatures during the dissolution of gases in water.

Instructions for question No. 41 to 50

Response	first statement	second statement
(1)	True	true and correctly explain the 1 st statement
(2)	True	true, but does not explain the 1 st statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
41.	When H ₂ S gas was sent through an aqueous solution containing Cu ²⁺ and Ni ²⁺ ions after the addition of aqueous ammonia, only NiS precipitates.	The solubility product coefficient of NiS is greater than that of CuS.
42.	A mixture of para- and ortho-nitrophenol can be separated from one another by fractional distillation process.	Phenols form intermolecular Hydrogen bonds.
43.	In any reaction, the half life depends on its rate constant.	In every time when the rate of a reaction is increased, its half life decreases.
44.	When alcohols relevant to a given molecular formula were considered, the boiling points of isomers with side chains are always greater than the boiling points of isomers without side chains.	In isomers of alcohols, when the number of side chains are increased, the strength of London forces decreases.
45.	CH ₃ ONa is more basic than C ₆ H ₅ ONa.	CH ₃ O ⁻ and C ₆ H ₅ O ⁻ are the conjugate bases of CH ₃ OH and C ₆ H ₅ OH respectively and C ₆ H ₅ OH is more acidic than CH ₃ OH.
46.	When there is at least a small amount of a liquid is present, the vapour pressure of a liquid does not depend on its volume.	The vapour pressure of a liquid depends on the strength of intermolecular attractive forces.

47.	An aqueous solution of Ag^+ and an aqueous solution of Zn^{2+} cannot be separately identified from one another using an NaOH solution.	AgOH and Zn(OH)_2 are stable white colored precipitates.
48.	When the volume of a gas was increased at a higher temperature, it approaches more closer to an ideal behavior.	The Van der Waal's constants for real gases approaches zero at high temperatures and low pressures.
49.	The rate of an exothermic reaction decreases when the temperature was increased.	When the temperature is increased, the collisions between reactant molecules increases.
50.	The presence of CO_2 in excess in the atmosphere causes global warming.	Even though CO_2 absorbs Infra-red radiation, it cannot stay in the atmosphere for a long period of time.

*** 30.11.2023 ***