SECTION A [40 MARKS]
ANSWER ALL QUESTIONS

Question 1

a) For each question,there are four alternatives A, B, C and D. Choose the correct alternative and circle it. DONOT circle more than ONE alternative. If there is more than ONE circled alternative, No score shall be awarded. **[25]**

i. Which of the following is the effect of increase in the temperature of a given solution?

A Molarity increases

B Molality increases

C Molarity decreases

D Molality decreases

ii. For the given equation in aqueous solution:

$CH_3COOH \leftrightarrow H^+ + CH_3COO^-$, the dissociation constant (K_a) is given as

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$$

What will happen when NaOH is added to the above solution at the same temperature?

A H^+ concentration increases

B CH_3COO^- concentration increases

C CH_3COO^- concentration decreases

D CH_3COOH concentration increases

iii. The greater reactivity of acetaldehyde compared to acetone towards nucleophile is due to

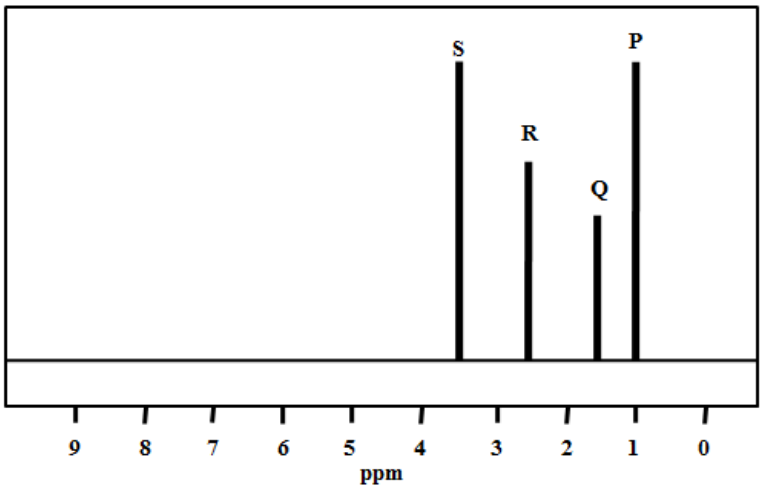
A greater +I effect.

B lower +I effect.

C greater –I effect.

D lower –I effect.

iv. The NMR spectrum of a certain organic compound is given below.



The most shielded proton is represented by

A P.

B Q.

C R.

D S.

v. Electrodes X and Y are dipped in acid solution in two separate containers and the following observation were recorded.

Electrode	**Observation**
X	H_2 gas evolved
Y	H_2 gas not evolved

This indicates that the electrode potential of

A X is lower than Y.

B X is higher than Y.

C X and Y are positive.

D X is positive and Y is negative.

vi. Which of the following shows the correct order of deprotonation of carboxylic acids?

A $CH_3CHClCOOH > ClCH_2CH_2COOH > CH_3C(Cl)_2COOH$

B $CH_3C(Cl)_2COOH > CH_3CHClCOOH > ClCH_2CH_2COOH$

C $ClCH_2CH_2COOH > CH_3C(Cl)_2COOH > CH_3CHClCOOH$

D $CH_3CHClCOOH > CH_3C(Cl)_2COOH > ClCH_2CH_2COOH$

vii. For a certain order reaction, the unit of rate constant is found to be t^{-1} (per time).

Which one of the following figures represents the given reaction?

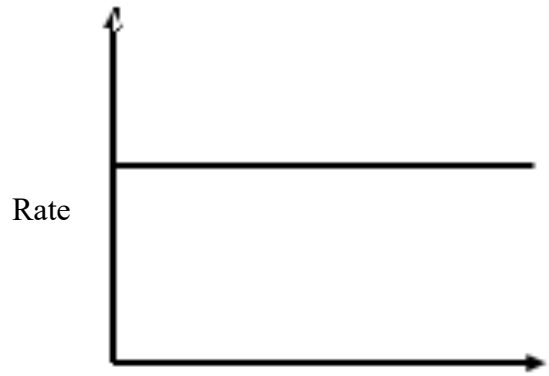


Figure I

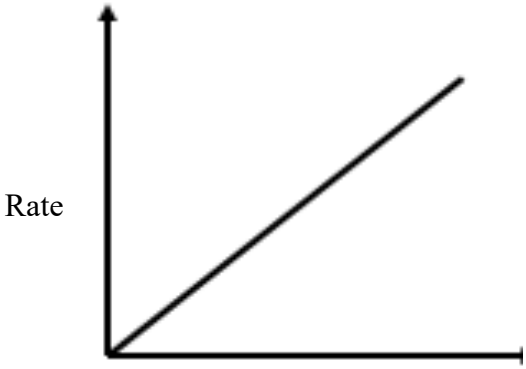


Figure II

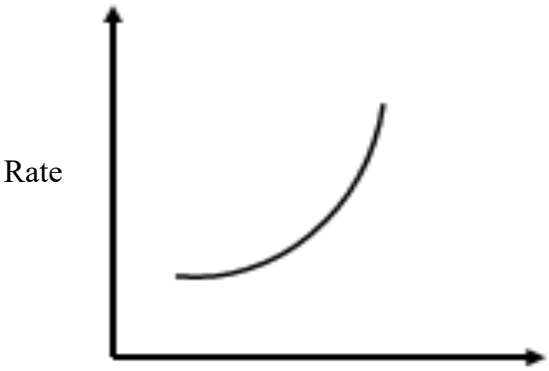


Figure III

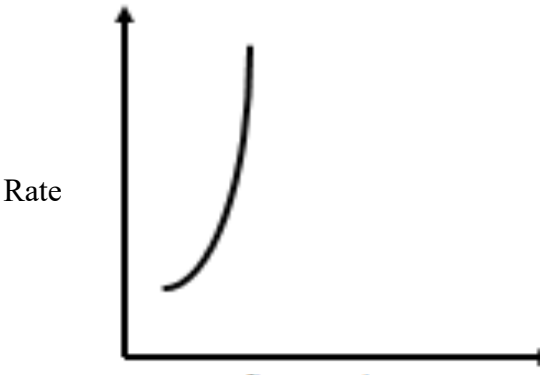


Figure IV

A Figure I

B Figure II

C Figure III

D Figure IV

viii. Acetamide must be stored in a tightly closed container. Why?

A It has a pungent smell.

B It is deliquescent in nature.

C It reacts when exposed to air.

D It fumes when exposed to air.

ix. For the reaction:

$$Cl_{(g)} + Cl_{(g)} \rightarrow Cl_{2(g)} + \text{Energy}$$

Which of the following is correct?

A $\Delta H = 0$ and $\Delta S > 0$.

B $\Delta H > 0$ and $\Delta S > 0$.

C $\Delta H < 0$ and $\Delta S = 0$.

D $\Delta H < 0$ and $\Delta S < 0$.

x. The boiling points of different types of amines depend on the number of hydrogen bonds that they can form. Which of the following is the correct order of their boiling points?

A $C_2H_5NH_2 > (CH_3)_2NH > (CH_3)_3N$

B $(CH_3)_2NH > (CH_3)_3N > C_2H_5NH_2$

C $(CH_3)_3N > (CH_3)_2NH > C_2H_5NH_2$.

D $(CH_3)_3N > C_2H_5NH_2 > (CH_3)_2NH$

xi. A radioactive element X, present in group 15 in the periodic table emits an alpha particle and a beta particle successively and changes into an element Y. The group number of the new element Y will be

A 17.

B 16.

C 14.

D 15.

xii. When a plane polarized light is passed through a sample of amino acid, the plane polarized light gets rotated in clock wise direction. Which of the following characteristic is appropriately associated with the amino acid molecule?

A chiral and symmetric

B chiral and asymmetric

C achiral and symmetric

D achiral and asymmetric

xiii. Given below is the structure of a compound that acts as a ligand in the formation of complex compound.

$$H_2N - CH_2 - CH_2 - NH_2$$

Which of the following is correct with regard to the compound?

A neutral and bidentate

B cationic and bidentate

C anionic and bidentate

D anionic and hexadentate

xiv. In acid base titration between HCl and NH_4OH, methyl orange indicator changes its colour from yellow to red. What is the cause of the change in colour?

A low concentration of H^+ ions

B high concentration of H^+ ions

C low concentration of OH^- ions

D high concentration of OH^- ions

xv. In IR spectroscopy, the bonds between atoms in the molecules are visualized as springs which undergo bending and stretching vibration. The following are four types of bending vibrations.

I. scissoring

II. rocking

III. wagging

IV. twisting

Which bending vibrations occurs out of plane?

A I and II

B II and III

C III and IV

D I, II and III

xvi. Benzoic acid undergoes dissociation as follows:

$$C_6H_5COOH \leftrightarrow C_6H_5COO^- + H^+$$

If the dissociation constant of C_6H_5COOH is 6.46×10^{-5}, what is the dissociation constant of $C_6H_5COO^-$ at 25ºC?

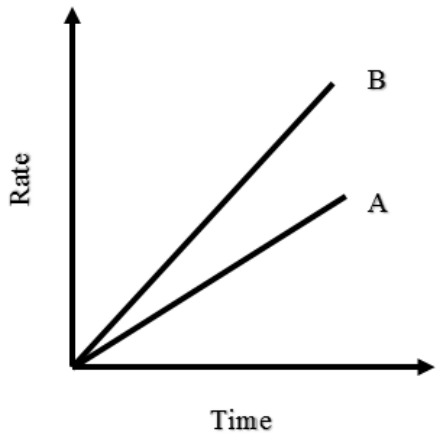
A 1.55×10^{-10}

B 4.119×10^{-10}

C 6.46×10^{-14}

D 5.28×10^{-14}

xvii. The plot of rate of chemical reaction against time is given below.



The graph line can be moved from A to B by reducing which of the following?

A surface area

B temperature

C intensity of light

D physical size of the reactant

xviii. To investigate the nature of the product formed, Karma heated coconut oil with NaOH. The chemical equation for the reaction is shown below.

$$\text{Coconut oil} + NaOH \rightarrow X + \text{Glycerol}$$

Which of the following is the product X?

A soap

B ester

C alcohol

D biodiesel

xix. Tetraammineaquachlorocobalt (III) chloride is a coloured complex. Which of the following is the formula of the complex?

A $[CoCl(H_2O)(NH_3)_4Cl_2]$

B $[CoCl(H_2O)(NH_3)_4]Cl_3$

C $[CoCl(H_2O)(NH_3)_4]Cl$

D $[CoCl(H_2O)(NH_3)_4]Cl_2$

xx. The combustion of benzene is represented as:
$2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$.
What is the difference in values between ΔH and ΔE for this reaction at 25^0C?

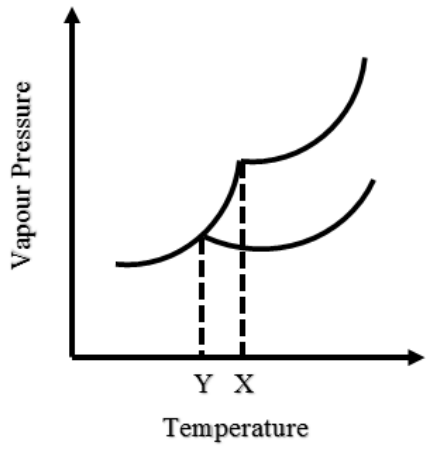
A -6.43 KJ.

B -7.43 KJ.

C +6.43 KJ.

D +7.43 KJ.

xxi. The vapour pressure curves of solvent and solution at a certain temperature are given below.



What is the difference between X and Y known as?

A elevation in boiling point

B depression in freezing point

C lowering of vapour pressure

D relative lowering of vapour pressure

xxii. In button cells used widely in wrist watches and other low current devices, the following reaction takes place.

$Zn\ (s) + Ag_2O\ (s) + H2O\ (l) \rightarrow Zn^{2+}\ (aq) + 2Ag\ (s) + 2OH^-\ (aq)$

Which of the following statement is correct about the button cell?

A Zn is cathode

B Ag_2O is cathode

C H_2O is cathode

D Ag_2O is used as salt bridge

xxiii. How many moles of white precipitate of AgCl would be formed when hexaamminecobalt (III) chloride reacts with $AgNO_3$ solution?

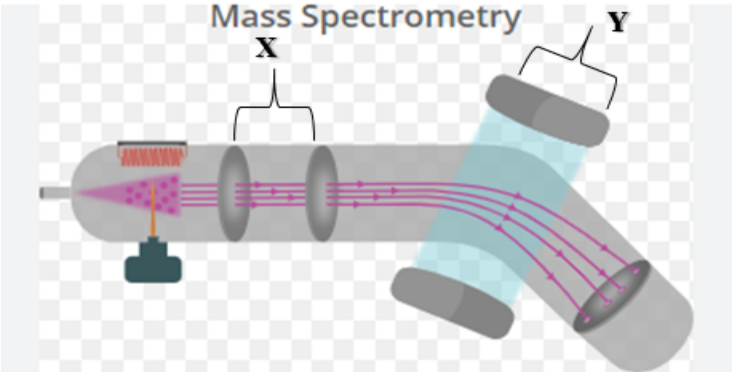
A 1

B 2

C 3

D 4

xxiv. The figure below shows the diagram of a mass spectrometer.



Which of the following is the correct processes that occurs at parts labelled X & Y respectively?

A deflection and ionisation

B detection and acceleration

C ionization and acceleration

D acceleration and deflection

xxv. Study the table given below.

Type of food	Fatty Acid present	Type of bonds present between C atoms in a chain
P	Lauric Acid	Single
Q	Oleic Acid	Double
R	Linoleic Acid	Double
S	Stearic Acid	Single

Which of the following pairs of food is recommended for consumption?

A P and Q
B Q and R
C R and S
D S and P

b) Match each item in column A with a most appropriate item in column B. [5]
Write the correct alphabet under the 'Answer' column in the space provided.

Answer	Column A	Column B
	i. Preservation of jams, jellies and pickles	A) acetic acid
	ii. Donates and accepts protons	B) amino acids
	iii. Platinum black in standard hydrogen electrode	C) reverse osmosis
	iv. Order and molecularity from balanced equation	D) ethyl amine
	v. Independent of quantity of matter present	E) ketones
	vi. Oxidation of 2-propanol	F) osmosis
	vii. Silver mirror with Tollen's reagent	G) extensive property
	viii. Purification of sea water	H) amphiprotic
	ix. Hydrolysis of protein	I) surface area
	x. Colorless liquid with fishy smell	J) elementary reaction
		K) formic acid
		L) intensive property

c) Fill in the blanks with the most appropriate word(s). **[5]**

i. The presence of carbonyl group in aldehydes and ketones can be tested by using the reagent _____.

ii. The two sites on which carboxylic acids form intermolecular hydrogen bonds are _____and _____.

iii. Concentrated sulphuric acid used in esterification reaction acts as a dehydrating agent as well as _____.

iv. If osmolarity of solution A is greater than solution B, then solution A is _____ with respect to solution B.

v. According to Lewis concept, a neutralization reaction takes place by transfer of electrons from _____to _____.

vi. In a bimolecular reaction when one of the reactants is taken in excess, the reaction becomes kinetically of _____order.

vii. In NMR spectrum, the splitting pattern of $-CH_2$ proton in ethyl bromide will be _____.

viii. The nuclei whose n/p value lies above the stability belt will emit _____to become stable.

d) Write the appropriate letter T for true and F for false against each statement. **[5]**

i.	Molecular mass of non-volatile solute is directly proportional to colligative property.	
ii.	pH of pure water increases with temperature.	
iii.	Iron (E^0_{red} = -0.44 V) can be protected from rusting by coating it with zinc (E^0_{red} = -0.44 V).	
iv.	Laws of thermodynamics are applicable only to matters in bulk.	
v.	Emission of β-particle from radioactive substance results in the formation of isotope.	
vi.	Aniline is the most basic of all the amines.	
vii.	Amino acids are least soluble at isoelectric point.	
viii.	TLC technique is better than HPLC in analysis of trace compounds.	

ix.	EMF of a cell is directly proportional to the concentration of ions in the anodic half-cell.		
x.	The concentration of 1.0N HCl solution is equal to 1.0M HCl solution.		

SECTION B [60 MARKS]
ATTEMPT ANY SIX QUESTIONS

Question 2

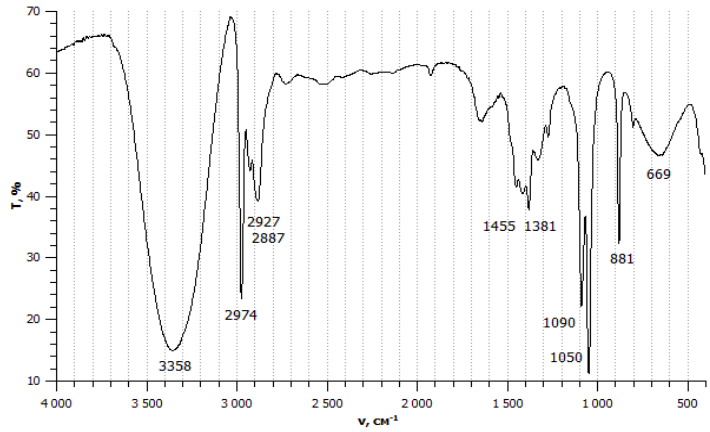
a) **[1]**

i. Define transition element.

ii. List at least **TWO** characteristics of transition elements. **[1]**

b) An organic compound with molecular formula C_3H_6O gives two carbonyl compounds. Write the structural formulas and IUPAC names of the two carbonyl compounds. **[2]**

c) A compound with molecular formula C_2H_6O gives the following IR spectrum. Study the spectrum and answer the questions that follow.



i. How many signals does the compound produce in NMR spectrum? **[1]**

ii. Which class of organic compound would be produced if the compound identified in (i) reacts with carboxylic acid in presence of concentrated H_2SO_4? **[1]**

d) Certain chemical analysis requires an alkaline medium with a pH range of 9.0-11.0. A sample of 500 mL solution containing 1.5 gram of NaOH is prepared. Can this solution be used in the chemical analysis? Justify with calculations. **[2]**

e) First law of thermodynamics is mathematically expressed as $\Delta E=q+w$. **[2]**

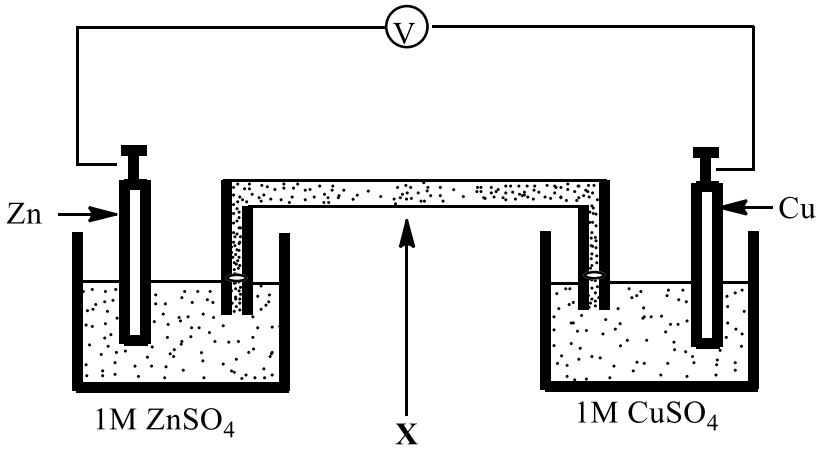
Formulate the first law of thermodynamics for:

i. Isochoric process

ii. Adiabatic process

Question 3

a) A schematic diagram of an electrochemical cell is shown below. Study the diagram and answer the questions that follow.



i. Mention **ONE** function of X. $[\frac{1}{2}]$

ii. What would happen to the voltage if X is removed? $[\frac{1}{2}]$

iii. Mention **TWO** characteristics of a substance that can be used as X. **[1]**

b) An organic compound 'A' which gives brisk effervescence when treated with $NaHCO_3$ reacts with ammonia to give compound 'B'. Compound 'B' on treating with bromine water and potassium hydroxide gives compound 'C'.

i. To which class of compounds do A, B and C belong? $[1\frac{1}{2}]$

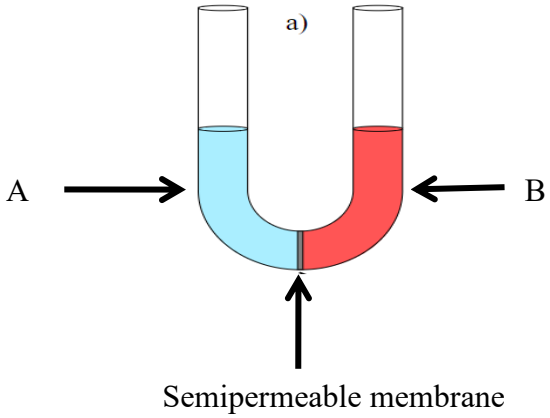
ii. Name the reaction that converts B to C and mention its importance. $[1\frac{1}{2}]$

c) For the reaction between haemoglobin (Hb) and carbonmonoxide (CO) the rate of reaction is found to be first order. Based on this information, study the table below and answer the questions that follow. **[2]**

Expt. No	[Hb] mol/L	[CO] mol/L	Initial Rate mol/L/s
1	2.21	1.00	0.62
2	4.42	Y	1.24
3	X	2.40	2.26

Calculate the values of X and Y.

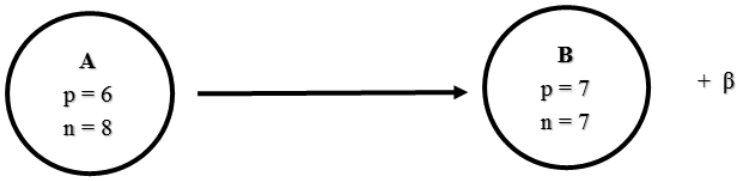
d) Solution A contains 58.06 g/L of glucose while solution B contains 17.82 g/L of urea. The two solutions are stored in a container separated by a semipermeable membrane at 37ºC as shown in the diagram below.



i. What changes would you observe in the levels of the liquids if it is kept standing for some time? Prove through mathematical calculation. **[1]**

ii. Mention **TWO** ways to prevent the above phenomenon. **[1]**

e) Radioactive element A disintegrates to give element B as shown in the diagram below. Identify elements A and B. **[1]**



A	
B	

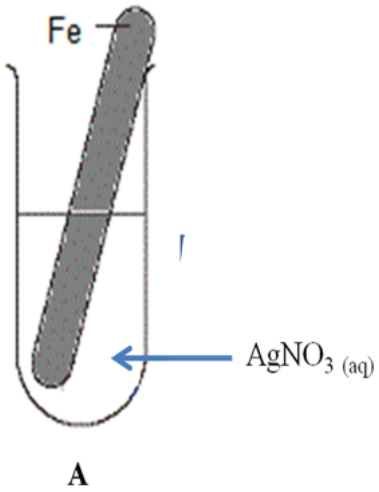
Question 4

a) The acid derived from ants has a lower pH than acid derived from vinegar. Justify the statement on the basis of

i. ease of release of H^+ ions. **[1]**

ii. stability of carboxylate ion. **[1]**

b) A strip of clean iron rod was immersed in a solution of silver nitrate. Based on the information, answer the following questions. (E^0 Ag^+/ Ag = +0.80 V, E^0Fe^{+2}/Fe = -0.44 V)



A

i. What changes would you observe in the iron rod during the course of the reaction? Explain with the help of an equation. $[1\frac{1}{2}]$

ii. What other observations would you make in the solution during the course of the reaction? Explain with the help of an equation. $[\mathbf{1\frac{1}{2}}]$

c) "High Performance Liquid Chromatography (HPLC) is basically a highly improved form of column liquid chromatography". How is HPLC a better analytical technique compared to column liquid chromatography? **[2]**

d) An ice cream vendor prepares sweet ice cubes using sugar at home. What are the conditions that must be considered to prepare such ice cubes? **[3]**

Question 5

a) The isoelectric point of alanine is 6.01. What would be its solubility at this pH? Explain. **[2]**

b) 200 J of heat flows from the surrounding at 25^0C into a large copper block at -10^0C.

i. Calculate the entropy changes of the system and the surrounding. **[1]**

ii. What does the value of change in entropy of the system and the surrounding indicate? **[1]**

c) There has been immense advancement in the discovery and use of radioactive substances in the world which has impacted the lives of people. Explain your views with proper justifications. **[3]**

d) Table below shows three indicators along with their pH range.

Indicator	pH range in which colour change occur
X	3.1 - 4.5
Y	7.0 - 8.0
Z	8.5 - 10.0

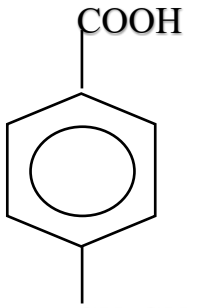
i. In an acid base titration between CH_3COOH and NaOH, which indicator would you choose? **[1]**

ii. Write the procedure for carrying out the titration using HCl and NH_4OH. **[1]**

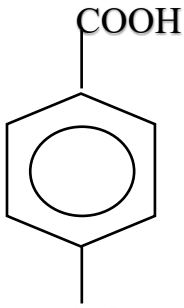
iii. Mention **TWO** precautions needed to be taken while performing the titration mentioned in (ii). **[1]**

Question 6

a) Following are the structural formula of two aromatic carboxylic acids. If NO_2 exerts similar inductive effect like that of halogens, compare their pKa values with proper justifications. **[2]**



A



B

b) Ammonia and oxygen react at a high temperature as:

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$. If the rate of disappearance of ammonia is 2.4×10^{-3} mol L^{-1} s^{-1},

i. Calculate the rate of formation of water. **[1]**

ii. Give **ONE** application of determining the rate of chemical process. **[1]**

c) Aniline is prepared in the laboratory as per the reaction:

$$C_6H_5NO_2 + 6[H] \xrightarrow{\text{Fe or Sn in HCl}} C_6H_5NH_2 + 2H_2.$$

Based on this information, answer the following questions.

i. What is the function of Fe or Sn in HCl? **[1]**

ii. When aniline reacts with HCl, $C_6H_5NH_3^+Cl^-$ is produced. What does this reaction indicate about the nature of aniline? **[1]**

d) A group of students constructed a cell using the following chemicals and materials.

Sl No	**Chemicals/Materials**
1	Mg strip
2	Cu strip
3	$MgSO_4$ (0.1M)
4	$CuSO_4$ (0.001M)

i. The cell constructed was not able to run a wall clock requiring EMF of 4.00 V. Why? Explain with the help of calculation. **[1]**

ii. What adjustment would you make in the cathodic half-cell so that the cell generates enough e.m.f to run the wall clock. **[1]**
($E°Mg_2+ / Mg = -2.37$ V and $E°Cu_2+ / Cu = +0.34$ V)

e) How is IR spectroscopy used to study the progress of the reaction given below. Explain. **[2]**

$$CH_3COCH_3 + HCN \xrightarrow{\text{base}} CH_3CCNOHCH_3$$

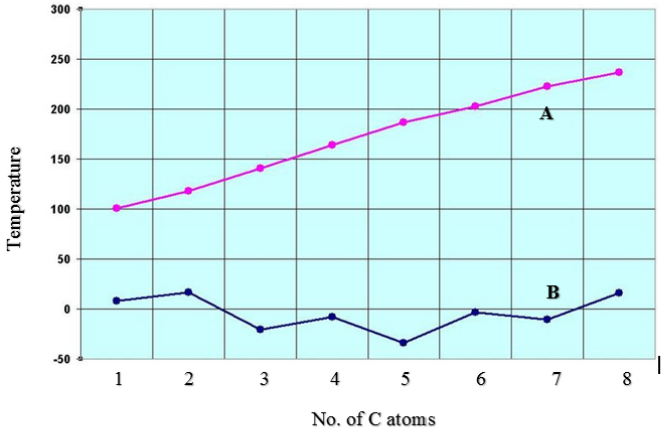
Question 7

a) Give reasons for the following:

i. Evaporation is a spontaneous process although ΔH for the process is positive. **[1]**

ii. Entropy of the universe is increasing while energy remains constant. **[1]**

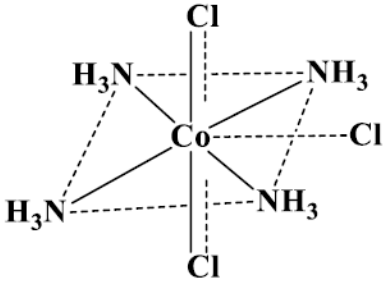
b) The two common physical properties of carboxylic acids which vary with their molecular mass is represented in the graph given below. Observe the graph carefully and answer the questions that follow.



i. Identify the physical properties represented by plot A and B respectively. **[2]**

ii. Explain the basis of variation of the physical property represented by plot B. **[1]**

c) The structure below represents a complex compound. Study the structure and answer the questions that follow.



i. Write the formula and IUPAC name of the complex compound. **[1]**

ii. Identify the Lewis acid and base in the complex. **[1]**

d) A student is provided with the following substances to produce an organic substance.

Sl No	Materials
1	Fats and Oil
2	CH_3OH
3	NaOH solution

i. Name the major product obtained when the given substances are chemically combined. **[1]**

ii. List **TWO** characteristics of the product obtained in i. **[1]**

iii. What are the advantages of this product? **[1]**

Question 8

a) C_6H_5CHO gives positive result with Tollen's reagent but not with Fehling's solution. Explain. **[2]**

b) Study the table given below and answer the question. **[2]**

Solutions	**Weight of solute**	**Molecular mass of solute**	**Weight of water**
A	3.2 gm	342	100gm
B	…….gm	180	10gm

What weight of solute is required to be added to solution B to produce the same relative lowering of vapour pressure as that of solution A?

c) A student performed a redox titration using two solutions as follows: **[2]**

C–1 is a solution of 0.0095 M $KMnO_4$.

C–2 is a solution of $[(NH_4)_2SO_4FeSO_4.6H_2O]$ of unknown molarity.

The student obtained the following data from the experiment.

Sl. No	**Volume of $[(NH_4)_2SO_4FeSO_4.6H_2O]$ solution (mL)**	**Burette Reading (mL)**		**Volume of $KMnO_4$ used (mL)**
		Initial reading	**Final reading**	
1	10	10	19.7	9.7
2	10	19.7	29.2	9.5
3	10	29.2	38.7	9.5

A simplified molecular reaction is given below.

$$2KMnO_4 + 10[(NH_4)_2SO_4.\ FeSO_4.6H_2O] + \rightarrow 5Fe_2(SO_4)_3 + 2MnSO_4$$

Calculate the molarity of hydrated ammonium iron (II) sulphate solution, C-2.

d) Zinc lies above copper in metal reactivity series. What would happen to the blue colour of $CuSO_4$ solution when Zinc rod is dipped in it? Explain on the basis of property of transition elements. **[2]**

e) The table below shows the types of tests that can be performed to differentiate various amines.

Amines	**1. Nitrous acid test**	**2. Carbyl amine Test**
Primary aliphatic amine	Production of N_2 gas (bubbles)	Isocyanide with unpleasant smell is produced
Secondary aliphatic amine	Yellow oily layer	No reaction
Tertiary aliphatic amine	No visible sign of reactions	No reaction
Primary aromatic amine	Production of "diazonium salts"	Isocyanide with unpleasant smell is produced

Identify **ONE** test from the table to distinguish the following pairs of amines.

i. $(CH_3)_3N$ and $(CH_3)_2NH$ **[1]**

ii. $C_6H_6NH_2$ and $(CH_3)_3N$ **[1]**

Question 9

a) With the help of balanced equations, write any **TWO** relevant chemical tests to distinguish CH_3COOH from other organic compounds. **[2]**

b) A group of chemistry students was given a project to separate individual amino acids from a mixture. They used Thin Layer Chromatography in the separation. The data obtained is given in the table below.

Sl. No	Amino Acids	R_f Value
1	Alanine (Ala)	0.52
2	Arginine (Arg)	0.16
3	Threonine (Thr)	0.12
4	Tyrosine (Tyr)	0.68

Use the information from the table to answer the following questions.

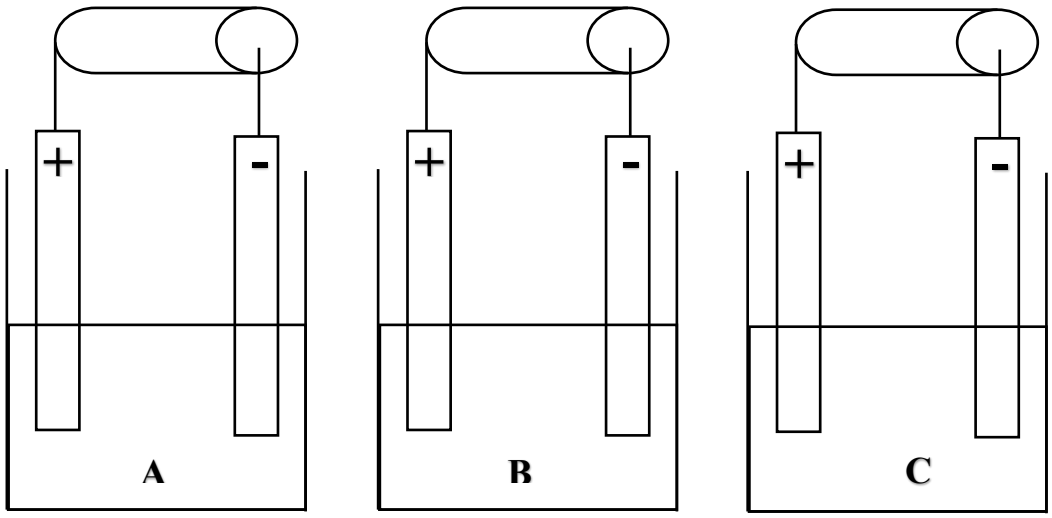
i. Calculate the distance travelled by each amino acid and use the value obtained to detect the amino acids in the given TLC plate if the distance travelled by solvent front is 10 cm. **[1]**

ii. Of the four amino acids which one is least polar? Justify your answer. **[1]**

c) Three amino acids with specific isoelectric points are shown in the table below. **[2]**

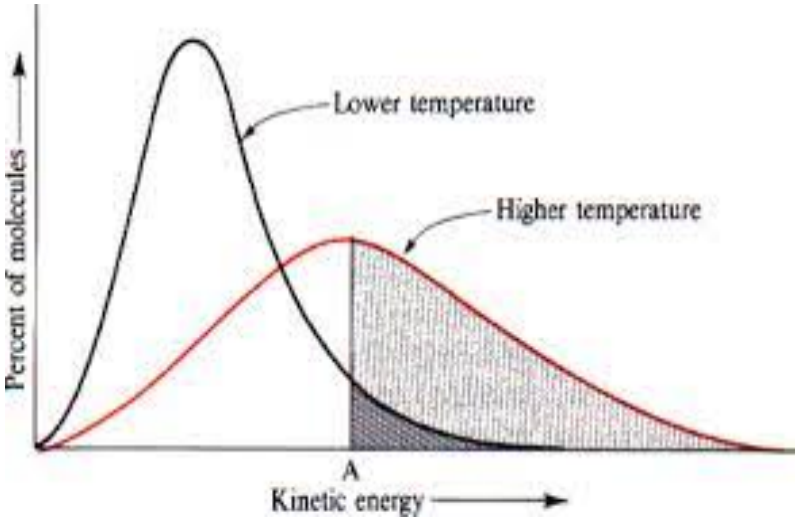
Amino Acid	Isoelectric Point
X	3.6
Y	6.1
Z	9.7

Which amino acids can be separated by each of the set up given below? Explain.



$[H^+] = 2.5 \times 10^{-4}$ $[H^+] = 7.9 \times 10^{-7}$ $[H^+] = 2.0 \times 10^{-10}$

d) The diagram below gives information on the effect of increase in temperature on the rate of a reaction. **[2]**



What would happen to the rate of chemical reactions if temperature is increased? Why?

e) Write the product formed in the following reactions. **[2]**

i. $CH_3CHO + [O] \xrightarrow{\text{Alkaline } KMnO_4} \_\_\_\_\_$

ii. $CH_3COCH_3 + [O] \xrightarrow{\text{Alkaline } KMnO_4} \_\_\_\_\_$
