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. Do not circle more than ONE alternative. If there is more than one choice circled, NO score will be awarded. **[15]**

(i) The number of gram-equivalents of solute dissolved per litre of solution is

A molarity.
B molality.
C normality.
D mole fraction.

(ii) When ammonia molecule is bombarded with an electron, the molecular ion formed will have m/e value equal to

A 14.
B 16.
C 17.
D 18.

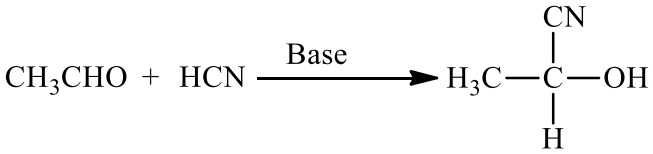
(iii) When a radioactive element emits one β-particle, the daughter element will be displaced

A two groups left in the periodic table.
B two groups right in the periodic table.
C one group left in the periodic table.
D one group right in the periodic table.

(iv) Aliphatic amines are derivatives of ammonia (NH_3) in which one or more H-atoms have been replaced by alkyl group(s). The increasing order of the basic strength of the following amines is

A $R_3N < RNH_2 < R_2NH < NH_3$.
B $RNH_2 < R_2NH < R_3N < NH_3$.
C $R_2NH < NH_3 < R_3N < RNH_2$.
D $NH_3 < R_3N < RNH_2 < R_2NH$.

(v) The following reaction is an example of



A addition reaction.
B reduction reaction.
C elimination reaction.
D condensation reaction.

(vi) The standard reduction potential for the following electrodes are:

Mg^{2+} / Mg = -2.38 V
$2H^{+}$ / H_2 = 0.00 V
Cu^{2+} / Cu = 0.34 V
Zn^{2+} / Zn = -0.76 V

The electrode showing the strongest reducing power is
A Mg.
B Cu.
C H_2.
D Zn.

(vii) Nylon threads are made up of

A polyvinyl polymer.
B polyester polymer.
C polyamide polymer.
D polyethene polymer.

(viii) Hydrolysis of simple proteins in the presence of either acids, alkalis or enzymes gives

A hydroxyl acids.
B amino acids.
C fatty acids.
D alcohols.

(ix) One mole of an ideal gas at 27˚C expands isothermally and reversibly from a volume of 10 dm^3 to 20 dm^3. The change in internal energy (ΔE) of the system will be

A -1729.2 J.
B +1729.2 J.
C + 0.0 J.
D -101.3 J.

(x) The boiling point of carboxylic acid is higher than those of hydrocarbons and alcohols of comparable molecular masses. This is due to

A intermolecular hydrogen bonding.
B dipole-dipole interaction.
C van der Waals' forces.
D coordinate bonding.

(xi) The oxidation number of Cr in the complex $[Cr(H_2O)_4Cl_2]NO_3$ is

A -1.
B +3.
C +1.
D +7.

(xii) Bronsted base are those substances which can accept proton(s). All of the following are examples of Bronsted base ***EXCEPT***

A S^{2-}.
B CO_3^{2-}.
C NH_3.
D NaOH.

(xiii) For a process to be spontaneous

A $\Delta H - T\Delta S$ must be positive.
B $\Delta H - T\Delta S$ must be negative.
C $\Delta H + T\Delta S$ must be positive.
D $\Delta H + T\Delta S$ must be negative.

(xiv) The experimentally determined rate law and the rate expression obtained from a balanced chemical equation is the same for the following reaction:

$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$

The unit for rate constant (K) for the reaction given above is

A $mol^{-1} t^{-1}$.
B $mol^{-1} l^{1} t^{-1}$.
C $mol^{-2} l^{2} t^{-2}$.
D t^{-1}.

(xv) When vegetable oil is treated with methanol in the presence of NaOH/KOH as a catalyst, the products formed are

A soap and glycerol.
B soap and detergent.
C detergent and glycerol.
D biodiesel and glycerol.

(b) Fill in the blanks with appropriate word/s. **[5]**

(i) The peak corresponding to the ion of maximum abundance is called ……

(ii) The IUPAC name for  is …….

(iii) The denticity of ethylenediamine is …… while ammonia is ……..

(iv) 4.0 gm of NaOH is dissolved in 1000g of water. The molality of this Solution will be ……

(v) When salicylic acid is heated with acetic anhydride in the presence of phosphoric acids, the products formed are acetic acid and ……

(vi) For a first order reaction, the half-life of a reactant is 5 minutes. The percentage of the reactant after 20 minutes will be ……

(vii) For a cell reaction: $Ni_{(s)} + CuSO_{4(aq)} \longrightarrow NiSO_{4(aq)} + Cu_{(s)}$, the symbolic representation of the cell is ……

(viii) The pH and pOH values of a solution having H^+ ion concentration of 1×10^{-5} mol l^{-1} at 25˚C is …… and ……

(c) Match each item of Column A with the most appropriate item of Column B. Rewrite the correct pairs by writing the alphabet against the number in the spaces provided. **[5]**

Column A	**Column B**
(i) Synthesis of azo dyes	a. dry cell
(ii) Preparation of ethylamine	b. oxalic acid
(iii) Alkaline hydrolysis of ester	c. Magnetic Resonance Imaging
(iv) Discharges pink colour of acidified $KMnO_4$ solution	d. first order reaction
(v) Gives wine red colour with alkaline sodium nitroprusside solution	e. coupling reaction
(vi) Rechargeable cell	f. saponification
(vii) Detection of impurities in a compound	g. acetone
(viii) Medical diagnostic technique	h. Mendius reaction
(ix) Structural isomer identification	i. second order reaction
(x) Half-life depends upon initial concentration of the reactant	j. Nicad cell
	k. Nuclear Magnetic Resonance
	l. Infrared spectroscopy

(i)
(ii)
(iii)
(iv)
(v)
(vi)
(vii)
(viii)
(ix)
(x)

(d) Correct the following statements by changing only the underlined words. Rewrite ONLY the correct answer. DO NOT copy the whole sentence. **[5]**

(i) Fats and oils are triesters of <u>ethylene glycol</u> and fatty acid.

(ii) When acetaldehyde is warmed with Fehling's solution, it gives a red precipitate of <u>2Ag</u>.

(iii) When an aqueous solution of NaCl is crystallized, the entropy of the system <u>remains same</u>.

(iv) <u>IR spectroscopy</u> technique is used for the separation of non-volatile and thermally unstable chemicals and biological compounds from their mixture.

(v) The collisions between the reacting molecules are effective only when they acquire <u>activation</u> energy.

(e) Answer the following questions.

(i) State Ostwald's Dilution law. **[1]**

(ii) Name the method used for the measurement of osmotic pressure of a solution. **[½]**

(iii) Define the boiling point of a liquid in relation to its vapour pressure. **[1]**

(iv) What is observed when acetic acid is treated with ethanol in presence of a small amount of conc. H_2SO_4? **[1]**

(v) Calculate the entropy change for the vaporization of water to steam at 100˚C. Given: Heat of vaporization = 40800 $Jmol^{-1}$. **[1]**

(vi) Convert benzyl alcohol to benzoic acid. **[1]**

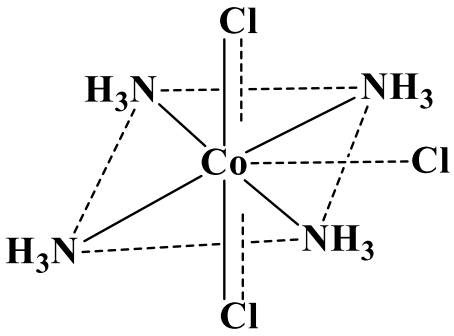
(vii) Give ***TWO*** advantages of fuel cells over ordinary cells. **[1]**

(viii) Write the reaction for the preparation of terylene. **[1]**

(ix) Name the aldehyde used in preserving biological specimens. **[½]**

(x) How do radioactive elements emit β-particle (electron) although their nucleus does not have an electron? **[1]**

(xi) Based on the structure given below, write the oxidation number and coordination number of the central atom. **[1]**



SECTION B (60 marks)
Answer any **SIX** *questions.*

Question 2.

(a) (i) Define cryoscopic constant. **[1]**

(ii) Give ***ONE*** use of colligative property. **[1]**

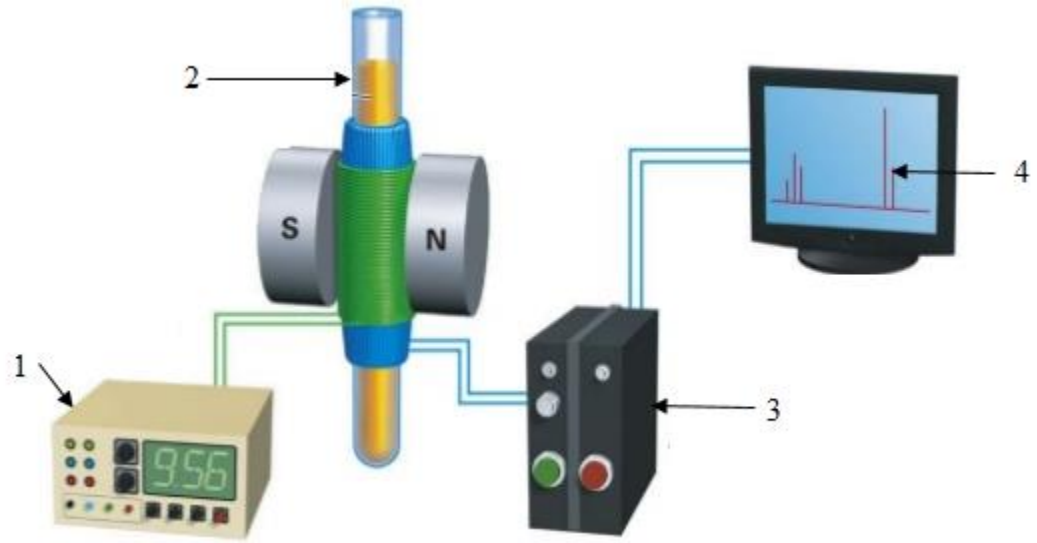
(b) Study the pairs of chemical substances given below: **[2]**

1. NH_4OH and NH_4Cl
2. H_2CO_3 and $NaHCO_3$
3. H_3PO_4 and NaH_2PO_4

(i) Which buffer is present in human blood?

(ii) How does the buffer selected in (i) function? Explain the mechanism.

(c) Study the schematic diagram of Nuclear Magnetic Resonance (NMR) spectrometer and label the parts 1 to 4. **[2]**



1	
2	
3	
4	

(d) Study the reaction given below and answer the questions that follow. **[2]**

$CH_3COCl + H_2O \longrightarrow CH_3COOH + HCl$

(i) Name the reaction based on the type of reagent.

(ii) Show the reaction mechanism of (i).

(e) Write balanced chemical equations for the conversion of cane sugar to sodium oxalate. **[2]**

Question 3.

(a) The osmotic pressure of blood at 37˚C is 8.21 atm. How much glucose should be used in 1 litre of solvent for intravenous injection so that it is isotonic with the blood? **[3]**

(b) Of the two cells given below, one is not functional. Study the cells and answer the questions that follow: **[2]**

1. Ag/Ag^{+} // Cu^{2+}/Cu
2. Zn/Zn^{2+} // Cu^{2+}/Cu

Given: $E^{\circ}Cu^{2+}/Cu = 0.34$ V

$E^{\circ}Zn^{2+}/Zn = -0.76$ V

$E^{\circ}Ag^{+}/Ag = +0.80$ V

(i) Which cell will not function? Why?

(ii) How can the cell be made functional?

(iii) Write the correct representation of the cell.

(c) (i) What is Cannizzaro's reaction? **[½]**

(ii) Three aldehydes are given below: **[1½]**

A. Formaldehyde (HCHO)

B. Acetaldehyde (CH_3CHO)

C. Benzaldehyde (C_6H_5CHO)

1. Which one will not undergo Cannizzaro's reaction?

2. Write the balanced chemical equation of its reaction with $NaBH_4$.

(c) An organic compound 'A' with molecular formula C_2H_6O on oxidation with alkaline $KMnO_4$ gives a product 'B' with molecular formula C_2H_4O which gives silver mirror with Tollen's reagent. 'B' on further oxidation with alkaline $KMnO_4$ gives compound 'C' with molecular formula $C_2H_4O_2$ which gives brisk effervescence with $NaHCO_3$.

Write the balanced chemical equations for the following conversions. **[2]**

(i) Organic compound 'A' to 'B'.

(ii) Organic compound 'B' to 'C'.

(d) A fragment obtained from ethanol has the formula $[CH_3CH_2]^+$, calculate its m/e value. **[1]**

Question 4.

(a) The table given below shows the solubility of gases in a fixed volume of water.

Pressure → Gas ↓	**1 atm.**	**4 atm.**	**8 atm.**
N_2	0.3 g	1.2 g	2.4 g
O_2	0.7 g	2.8 g	5.6 g
CO_2	3.3 g	13.2 g	26.4 g

State the law governing the above observation. **[1]**

(b) For a cell, Zn / $Zn^{2+}_{(0.01\ M)}$ // $Ag^{+}_{(0.02\ M)}$ /Ag. Given: $E^{\circ}Zn^{2+}/Zn$ = - 0.76 V, $E^{\circ}Ag^{+}/Ag$ = + 0.80 V,

(i) Write the balanced net cell reaction. **[1]**

(ii) Calculate the emf of the cell. **[2]**

(c) (i) Why are Cd^{2+} salts colourless while Fe^{3+} salts coloured? **[1]**

(ii) Give the IUPAC name of $[Cr(NH_3)_4](NO_3)_3$. **[1]**

(d) Arrange the following acids in their increasing order of acidic strength. **[1]**
HCOOH, CH_3COOH, C_6H_5COOH

(e) On analysis by IR spectroscopy, two isomers A and B having molecular formula C_3H_6O show peaks at two different regions in the spectrum. Compound A shows peak at 1700cm^{-1} while compound B shows at 1720cm^{-1}.

(i) Based on this information, identify the functional groups of compounds A and B. **[1]**

(ii) How can the compounds A and B be differentiated by NMR spectrometry? **[1]**

(iii) Write the structural formula of compounds A and B. **[1]**

Question 5.

(a) Write ***TWO*** conditions for an electrochemical cell to act as a commercial cell (battery). **[1]**

(b) The rate constant for a reaction is $1.6 \times 10^{-5} s^{-1}$ and $6.36 \times 10^{-3} s^{-1}$ at 600K and 700K respectively. Calculate the activation energy for the reactions. **[2]**

(c) What will happen to the entropy change (ΔS) in each of the following processes and why? **[2]**

(i) H_2 (298K, 1 atm.) $\longrightarrow$ H_2 (298K, 0.5 atm.)

(ii) H_2O (25˚C, 1 atm.) $\longrightarrow$ H_2O (0˚C, 1 atm.)

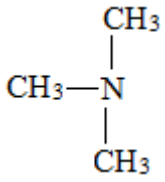
(d) When a primary amide is heated with bromine in presence of an alkali, a primary amine with one carbon atom less than amide is formed.

(i) What is the name of the reaction? **[½]**

(ii) What is the main application of this reaction? **[½]**

(iii) Write the balanced chemical equation using acetamide. **[1]**

(e) Study the table given below and answer the questions that follow.

	Alcohol	**Primary amine**	**Secondary amine**	**Tertiary amine**
Organic compound	Ethanol (C_2H_5OH)	Ethyl amine ($C_2H_5NH_2$)	Dimethyl amine (CH_3-NH-CH_3)	Trimethylamine 
Molar mass	46	45	45	59
Boiling point	350 K	290 K	280 K	277 K

Why is the boiling point of primary amine less than alcohol but greater than secondary and tertiary amine? **[2]**

(f) What is the finger print region? **[1]**

Question 6.

(a) Give ***TWO*** differences between rate of reaction and rate constant of a chemical reaction in the table given below. **[2]**

Rate of reaction	**Rate constant**

(b) What is a chemical shift in NMR spectroscopy? **[1]**

(c) (i) Using the information given below, calculate the enthalpy of the formation (ΔH_{for}) of NaCl. **[2]**

ΔH of sublimation of $Na_{(s)}$ is 100.5 $kJmol^{-1}$,
ΔH of dissociation of $Cl_{2(g)}$ is 240.0 $kJmol^{-1}$,
Ionization energy (IE) of Na is 490.0 $kJmol^{-1}$,
Electron affinity (EA) of $Cl_{2(g)}$ is 340.5 $kJmol^{-1}$ and
Lattice energy (ΔH_{lat}) of NaCl is 700.5 $kJmol^{-1}$

(ii) Give ***TWO*** applications of Born Haber cycle. **[1]**

(d) (i) What happens when acetone is warmed with 2, 4-dinitrophenyl hydrazine (2,4-DNP) solution? **[1]**

(ii) 'Aqueous solutions of amines are alkaline in nature.' Why? **[1]**

(e) Study the two amino acids given below and answer the questions that follow.

1. $NH_2CH(CH_3)COOH$
2. NH_2CH_2COOH

(i) Which amino acid is optically active? Justify your answer. **[1]**

(ii) Represent the optical isomer of (i). **[1]**

Question 7.

(a) The ionic product of water (K_w) increases with increase in temperature. This is related to $[H^+]$ as follows: $K_w = [H^+] [OH^-]$.

(i) What will happen to the pH of the water when it is boiled? Why? **[1]**

(ii) What will happen to the K_w and pH of the water when a base is added? **[1]**

(b) How many α and β particles are emitted when $^{232}_{90}Th$ changes to $_{82}Pb^{208}$? **[2]**

(c) For a reaction $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$, the standard heat of formation of HI is 26.8 kJ. Calculate the standard entropy change and state whether the reaction is exothermic or endothermic. **[2]**

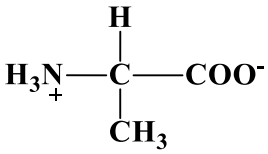
(d) Both acetyl chloride (CH_3COCl) and acetamide (CH_3CONH_2) are derivatives of carboxylic acid. Their reactivity towards nucleophilic substitution reaction depends on the magnitude of positive charge on the carbonyl carbon.

Which of the two will readily undergo nucleophilic substitution reaction? Why? **[2]**

(e) (i) On the basis of linkage, list the difference between polyamides and polyesters in the table given below. **[1]**

	Polyamides	**Polyesters**
Linkage		

(ii) The zwitterionic structure of alanine is:



Write its structure at pH = 2 and pH = 10. **[1]**

Question 8.

(a) 'Nylon-66 is a polyamide formed by the condensation copolymerization of hexamethylenediamine and adipic acid'.

Write the formula of the monomers and the balanced chemical equation for its preparation. **[2]**

(b) A buffer solution is prepared by mixing 1.8 M NH_4Cl and 1 M NH_4OH solution. Calculate the pH of this buffer solution if K_b for NH_4OH is 1.8×10^{-5}. **[2]**

(c) Plot a graph which can be used to calculate the activation energy of a reaction. What will be the relation between the slope of the graph and the E_a of the reaction? **[2]**

(d) For a complex compound 'tetracyanocuprate (II) ion',

(i) Calculate the charge of the complex ion and write its formula. **[1]**

(ii) Calculate the coordination number and predict its shape. **[1]**

(e) The table given below shows a list of test used for distinguishing various organic compounds. **[2]**

Silver mirror test	**Fehling test**	**Iodoform test**

Choose the appropriate test to distinguish between:

(i) C_6H_5CHO and HCHO

(ii) CH_3CHO and HCHO

Justify your answer.

For rough work