

CHEMISTRY

Paper – 1

(THEORY)

(Three Hours)

(Candidates are allowed additional 15 minutes for only reading the paper.
They must NOT start writing during this time.)

Answer all questions in Part I and six questions from Part II, choosing two questions from Section A, two from Section B and two from Section C.

All working, including rough work, should be done on the same sheet as, and adjacent to, the rest of the answer.

The intended marks for questions or parts of questions are given in brackets [].

Balanced equations must be given wherever possible and diagrams where they are helpful.

When solving numerical problems, all essential working must be shown.

In working out problems use the following data:

Gas constant $R = 1.987 \text{ cal deg}^{-1} \text{ mol}^{-1} = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} = 0.0821 \text{ dm}^3 \text{ atm K}^{-1} \text{ mol}^{-1}$

$1 \text{ l atm} = 1 \text{ dm}^3 \text{ atm} = 101.3 \text{ J}$. $1 \text{ Faraday} = 96500 \text{ Coulombs}$.

PART I

Answer all questions

Question 1

- (a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets: [5]
(concentrated sulphuric acid, methylamine, ethylamine, sp^2 , 2-propanol, s^{-1} , sp^3 , glycol, Cannizzaro's reaction, pyramidal, $\text{mol l}^{-1}\text{s}^{-1}$, Hofmann's degradation, glycerol, concentrated nitric acid, square planer, octahedral, concentrated hydrochloric acid)
- (i) Nitrogen atom in ammonia undergoes _____ hybridisation and the geometry of the molecule is _____.
- (ii) For a first order reaction, the unit of rate is _____ and that of rate constant is _____.
- (iii) When acetamide is treated with bromine and caustic soda, it gives _____ as the main product and the reaction is called _____.
- (iv) _____ is an example of trihydric alcohol and _____ is an example of dihydric alcohol.
- (v) Aqua regia is a mixture of _____ and _____ in the ratio of 3:1.

(b) Complete the following statements by selecting the **correct alternative** from the choices [5]
given:-

(i) Out of the following solutions, the one having the highest boiling point will be:

- (1) 0.1 M NaCl
- (2) 0.1 M BaCl₂
- (3) 0.1 M KNO₃
- (4) 0.1 M K₄[Fe(CN)₆]

(ii) 75% of a first order reaction was completed in 32 minutes. When was 50% of the reaction completed?

- (1) 24 minutes
- (2) 16 minutes
- (3) 8 minutes
- (4) 4 minutes

(iii) When zinc granule is dipped into copper sulphate solution, copper is precipitated because:

- (1) Both, copper and zinc have a positive reduction potential.
- (2) Reduction potential of copper is higher than that of zinc.
- (3) Reduction potential of zinc is higher than that of copper.
- (4) Both, zinc and copper have a negative reduction potential.

(iv) Among the following compounds, the one showing geometric isomerism is:

- (1) 2-chloro propane
- (2) 2-bromo-2-chlorobutane
- (3) 1,2 dichloro ethene
- (4) Glycine

(v) Of the following compounds, the one which is a Lewis acid is:

- (1) PCl₃
- (2) AlCl₃
- (3) NCl₃
- (4) AsCl₃

- (c) Answer the following questions: [5]
- 0.1 M urea solution shows less depression in freezing point than 0.1 M MgCl_2 solution. Explain.
 - What is the pH of a solution whose hydroxyl ion concentration is 10^{-2} M?
 - If neutral litmus solution is added to sodium acetate solution, what will you observe and why?
 - State why the boiling point of HF is very high.
 - Define piezoelectricity and give one use of piezoelectric crystals.
- (d) Match the following: [5]
- | | |
|------------------------|------------------|
| (i) Biuret | (a) DNA |
| (ii) Urotropine | (b) Amines |
| (iii) Purine | (c) Urea |
| (iv) Frasch process | (d) Formaldehyde |
| (v) Hinsberg's reagent | (e) Sulphur |

PART II

Answer six questions choosing two from Section A, two from Section B and two from Section C.

SECTION A

Answer any two questions

Question 2

- (a) (i) 46 gms of ethyl alcohol is dissolved in 18 gms of water. Calculate the mole fraction of ethyl alcohol. (at. wt of C = 12, O = 16, H = 1) [1½]
- (ii) The osmotic pressure of 0.01 molar solution of an electrolyte is found to be 0.65 atm at 27°C . Calculate the vant Hoff factor. What conclusion can you draw about the molecular state of the solute in the solution? [2½]
- (b) (i) State Faraday's First Law of Electrolysis. [1]
- (ii) How many electrons will flow when a current of 5 amperes is passed through a solution for 200 seconds? [1]

- (c) Give reasons for the following:
- A reaction/process will be spontaneous when it is exothermic and randomness is increasing. [2]
 - The number of hydronium ions increase when one litre of water is added to 1M acetic acid. [2]

Question 3

- What are semiconductors? What is the effect of increasing temperature on the conductivity of a semiconductor? [1½]
 - A compound AB has a cubic structure and molecular mass 99. Its density is 3.4 g cm^{-3} . What is the length of the edge of the unit cell? [3]
- What is the maximum work that can be obtained by the isothermal expansion of one mole of an ideal gas at 273K from 2.24 dm^3 to 22.4 dm^3 ? [2½]
 - State the geometry of PCl_5 molecule. Draw its structure. [1]
- Give two differences between a *sigma bond* and a *pi bond*. [2]

Question 4

- What is meant by common ion effect? [1]
 - Give the conjugate acid and the conjugate base for NH_3 . [1]
- Consider the reaction $2\text{Ag}^+ + \text{Cd} \rightarrow 2\text{Ag} + \text{Cd}^{2+}$. The standard reduction potentials of Ag^+ / Ag and $\text{Cd}^{2+} / \text{Cd}$ are + 0.80 volt and – 0.40 volt, respectively. [4]
 - Give the cell representation.
 - What is the standard cell emf, E° ?
 - What will be the emf of the cell if concentration of Cd^{2+} is 0.1M and Ag^+ is 0.2 M.?
 - Will the cell work spontaneously for the condition given in (iii) above?
- What is meant by *promoter*? Give an example. [1]
 - The solubility product of BaSO_4 is 1.5×10^{-9} . Find out its solubility in pure water. [1]
 - What is the dissociation constant of 0.1 M solution of a weak acid HA which is 4.5% ionized at 20°C ? [2]

SECTION B

Answer any two questions

Question 5

- (a) Give the IUPAC names for the following: [2]
- (i) $\text{Na}_3[\text{AlF}_6]$
 - (ii) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
- (b) For the complex ion of $[\text{Fe}(\text{CN})_6]^{3-}$: [3]
- (i) Show the hybridization diagrammatically.
 - (ii) Is it an inner orbital complex or an outer orbital complex?
 - (iii) State its magnetic property.

Question 6

- (a) Give balanced chemical equations for the following: [3]
- (i) Chlorine gas is passed through cold, dilute NaOH .
 - (ii) Sulphur dioxide gas is passed through NaOH solution.
 - (iii) Zinc is added to sodium argentocyanide solution.
- (b) Iron is ferromagnetic in nature. Explain why. [2]

Question 7

- (a) State the common oxidation state of: [1]
- (i) Lanthanides
 - (ii) Actinides
- (b) In a given transition series, there is no significant change in the atomic radii of elements with increase in atomic number. Explain why. [2]
- (c) Give reactions and the conditions required for preparation of the following compounds: [2]
- (i) XeF_6
 - (ii) XeOF_4

SECTION C

Answer any two questions

Question 8

- (a) Carry out the following conversions: [6]
- (i) Methyl chloride to acetic acid.
 - (ii) Benzene to benzoic acid.
 - (iii) Ethanol to acetone.
- (b) Deficiency of what vitamins will cause the following diseases: [1]
- (i) Night blindness.
 - (ii) Scurvy.
- (c) Give balanced equations for the following: [3]
- (i) Glycerol is heated with oxalic acid at 110°C (383K).
 - (ii) Acetamide is heated with sodium hydroxide.
 - (iii) Acetone reacts with hydrogen in the presence of heated copper.

Question 9

- (a) Identify A to F: [3]
- $$A \xrightarrow{\text{LiAlH}_4} \text{C}_2\text{H}_5\text{OH} \xrightarrow{\text{PBr}_3} \text{B} \xrightarrow{\text{KCN}} \text{C} \xrightarrow{\text{D}} \text{C}_3\text{H}_7\text{NH}_2 \xrightarrow{\text{HNO}_2} \text{E} \xrightarrow[\text{K}_2\text{Cr}_2\text{O}_7, \text{H}^+]{[\text{O}]} \text{F}$$
- (b) Give one good chemical test to distinguish between the following pairs of organic compounds: [3]
- (i) Benzaldehyde and acetone.
 - (ii) Methylamine and dimethylamine.
- (c) Draw the isomers of 2-hydroxy propionic acid. [1]
- (d) Give an example (equation) for each of the following name reactions: [3]
- (i) Aldol condensation.
 - (ii) Reimer-Tiemann reaction.
 - (iii) Rosenmund's reduction.

Question 10

- (a) An organic compound A has the molecular formula of C_7H_6O . When A is treated with NaOH followed by acid hydrolysis, it gives two products, B and C. When B is oxidised, it gives A. When A and C are each treated separately with PCl_5 , they give two different organic products D and E. [4]
- (i) Identify A to E.
- (ii) Give the chemical reaction when A is treated with NaOH and name the reaction.
- (b) Draw a pair of isomers for each of the following and name the type of isomerism: [4]
- (i) C_4H_{10}
- (ii) $C_2H_2Cl_2$
- (iii) CH_3COCH_3
- (iv) $C_4H_{10}O$
- (c) What are polyamides? Give one example of a polyamide and name its monomers. [2]