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

$1\ l\ atm = 1\ dm^3\ atm = 101.3\ J.$ *1 Farday = 96500 Coulombs.*

*Avagadro's number* $= 6.023 \times 10^{23}$.

---

### PART I (20 Marks)

*Answer all questions.*

**Question 1**

(a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets: **[5]**

(zero, first, second, increased, decreased, anode, cathode, active, inactive, potassium cyanide, internal, external, dependent, independent, red, benzoic acid, benzoin, common ion effect, salt hydrolysis, alkali, potassium hydroxide.)

(i) In a galvanic cell, electrons flow from _____ to _____ through the connecting wires.

(ii) Racemic mixtures are optically _____ because of _____ compensation.

(iii) Half life period of a _____ order reaction is _____ of the concentration of the reactant.

(iv) Benzaldehyde when treated with an alcoholic solution of _____ forms _____.

(v) Solubility of calcium oxalate is _____ in the presence of ammonium oxalate because of _____.

---

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

(i) The compound which is optically active is:

(1) 1-butanol

(2) 2-butanol

(3) 1-propanol

(4) 2-methyl-1-propanol

(ii) The salt which will not hydrolyse in aqueous solution is:

(1) Copper sulphate

(2) Sodium sulphate

(3) Potassium cyanide

(4) Sodium carbonate

(iii) Copper has the face centred cubic structure. The coordination number of each ion is:

(1) 4

(2) 12

(3) 14

(4) 8

(iv) For the reaction $2SO_2 + O_2 \rightleftharpoons 2SO_3$, the unit of equilibrium constant is:

(1) L $mol^{-1}$

(2) J $mol^{-1}$

(3) mol $L^{-1}$

(4) $[L\ mol^{-1}]^2$

(v) The deficiency of vitamin D causes:

(1) Rickets

(2) Gout

(3) Scurvy

(4) Night blindness.

(c) Answer the following questions: [5]

(i) Two metallic elements A and B have the following standard oxidation potentials:

A = 0·40v B = – 0·80v. What would you expect if element A was added to an aqueous salt solution of element B? Give a reason for your answer.

(ii) Two moles of $NH_3$ are introduced into one litre flask in which it dissociates at high temperature as follows: $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$. Determine Kc, if at equilibrium 1 mole of $NH_3$ remains.

(iii) Give balanced equation for the preparation of salicylaldehyde from phenol.

(iv) If the half life period for a first order reaction is 69·3 seconds, what is the value of its rate constant?

(v) Define cryoscopic constant.

(d) Match the following: [5]

| | | | |
|---|---|---|---|
| (i) | Colligative property | (a) | Polysaccharide |
| (ii) | Nicol prism | (b) | Osmotic pressure |
| (iii) | Activation energy | (c) | Aldol condensation |
| (iv) | Starch | (d) | Polarimeter |
| (v) | Acetaldehyde | (e) | Arrhenius equation |

## PART II (50 Marks)

*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) Ethylene glycol is used as an antifreeze agent. Calculate the amount of ethylene glycol to be added to 4 kg of water to prevent it from freezing at -6°C. ($K_f$ for $H_2O$ = 1·85 K $mole^{-1}$ kg) [3]

(ii) The freezing point of a solution containing 0·3gms of acetic acid in 30gms of benzene is lowered by 0·45K. Calculate the Van't Hoff factor. [2]
(at. wt. of C = 12, H = 1, O = 16, $K_f$ for benzene = 5·12K kg $mole^{-1}$).

(b) Name the law or principle confirmed by the following observations: [2]

(i) When water is added to 0·01M aqueous solution of acetic acid the number of hydrogen ions increase.

(ii) When 96500 coulombs of electricity is passed through acidulated water, 5·6 litres of oxygen at s.t.p. is liberated at the anode.

(c) Arrange Ag, Cr and Hg metals in the increasing order of reducing power. Given: [1]

$E^{\circ}_{Ag^{+}/Ag} = +0 \cdot 80V$

$E^{\circ}_{cr^{+3}/cr} = -0 \cdot 74V$

$E^{\circ}_{Hg^{+2}/Hg} = +0 \cdot 79V$

(d) In a first order reaction, 10% of the reactant is consumed in 25 minutes. Calculate: [2]

(i) The half life of the reaction.

(ii) The time required for completing 17% of the reaction.

**Question 3**

(a) Explain giving reasons why (Give equations in support of your answer):

(i) A solution of $NH_4Cl$ and $NH_4OH$ acts as a buffer. [2]

(ii) Cu is precipitated as CuS while Zn is not precipitated when $H_2S$ is passed through an acidic solution of $Cu(NO_3)_2$ and $Zn(NO_3)_2$ respectively. [2]

(b) (i) What is Schottky defect in a solid? [1]

(ii) A bcc element (atomic mass 65) has a cell edge of 420 pm. Calculate its density in gms/cm$^3$. [3]

(c) The rate of the reaction $H_2 + I_2 \rightleftharpoons 2HI$ is given by: [2]

$$\text{rate} = 1 \cdot 7 \times 10^{-19}[H_2][I_2] \text{ at } 25^{\circ}C.$$

The rate of decomposition of gaseous HI to $H_2$ and $I_2$ is given by:

$$\text{rate} = 2 \cdot 4 \times 10^{-21}[HI]^2 \text{ at } 25^{\circ}C.$$

Calculate the equilibrium constant for the formation of HI from $H_2$ and $I_2$ at 25°C.

**Question 4**

(a) (i) Give Lewis' definition for acids and bases. [1]

(ii) The solubility of $Ag_2CrO_4$ at 25°C is $8 \cdot 0 \times 10^{-5}$ moles/litre. Calculate its solubility product. [1]

(b) (i) Define molar conductance of a solution. State its unit. How is it related to the specific conductance of a solution? [2]

(ii) Calculate the value of $E_{cell}$ at 298K for the following cell: [3]

$Al / Al^{3+}$ (0·01M) // $Sn^{2+}$ (0·015M) / Sn

$E^{\circ}_{Al^{3+}/Al} = -1 \cdot 66$ volt and $E^{\circ}_{Sn^{2+}/Sn} = -0 \cdot 14$ volt

(c) (i) Calculate the degree of hydrolysis of 0·2(M) sodium acetate solution. [1]
(Hydrolysis constant of sodium acetate = $5 \cdot 6 \times 10^{-10}$ and ionic product of $H_2O = 10^{-14}$ at 25°C)

(ii) Explain why high pressure is used in the manufacture of ammonia by Haber's process. State the law or principle used. [2]

## SECTION B

*Answer any* **two** *questions.*

**Question 5**

(a) Give the IUPAC names of the following coordination compounds: [2]

(i) $K_2[Zn(OH)_4]$

(ii) $[Co(NH_3)_5(CO_3)]Cl$

(b) For the complex ion $[Fe(CN)_6]^{3-}$ state:

(i) The geometry of the ion. [1]

(ii) The magnetic property of the ion.

(c) What type of structural isomers are $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$ ? Give a chemical test to distinguish the isomers. [2]

**Question 6**

(a) For the molecule $XeF_2$ : [2]

(i) Draw the structure of the molecule indicating the lone pairs.

(ii) State the hybridisation of the central atom.

(iii) State the geometry of the molecule.

(b) Give balanced chemical equations for the following reactions: [3]

(i) Fluorine treated with dilute sodium hydroxide solution.

(ii) Hydrogen sulphide treated with concentrated sulphuric acid.

(iii) Potassium iodide treated with acidified potassium permanganate solution.

**Question 7**

(a) In the extraction of zinc from zinc blende: [2]

(i) Give an equation to show how zinc oxide is converted to zinc.

(ii) How is impure zinc finally electro-refined?

(b) Explain why: [3]

(i) Transition elements form coloured compounds.

(ii) Interhalogen compounds are more reactive than their constituent elements.

(iii) $Cu^{+}$ is diamagnetic but $Cu^{2+}$ is paramagnetic. (Z = 29)

## SECTION C

*Answer any* **two** *questions.*

**Question 8**

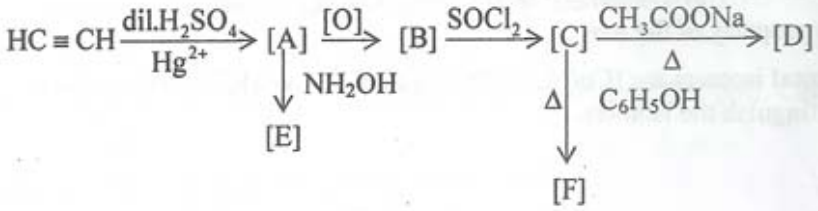
(a) How can the following conversions be brought about:

(i) Nitro benzene to benzene diazoniumchloride. [3]

(ii) Propanoic acid to ethylamine. [2]

(iii) Benzoic acid to benzaldehyde. [2]

(b) Identify the compounds A, B, C, D, E and F: [3]




**Question 9**

(a) Write balanced chemical equations for the following reactions and name the reactions: [3]

(i) Acetamide is heated with bromine and sodium hydroxide solution.

(ii) Benzaldehyde is treated with 50% sodium hydroxide solution.

(b) Give one chemical test to distinguish between the following pairs of compounds: [3]

(i) Acetone and phenol.

(ii) Formic acid and Acetic acid.

(c) (i) Name the type of isomerism exhibited by the following pairs of compounds: [2]

(1) $(C_2H_5)_2NH$ and $CH_3$- NH-$C_3H_7$

(2) 1-butanol and 2 methyl-1-propanol

(ii) Name the type of isomerism that the compound with molecular formula $C_3H_6O_2$ exhibits. Represent the isomers. [2]

**Question 10**

(a) Write balanced chemical equations for the following reactions: [4]

(i) Oxalic acid is treated with acidified potassium permanganate solution.

(ii) Benzoic acid is treated with a mixture of concentrated nitric acid and concentrated sulphuric acid.

(iii) Methyl magnesium iodide is treated with carbon dioxide and the product hydrolysed in acidic medium.

(iv) Ethylacetate is treated with ammonia.

(b) An organic compound [A] having molecular formula $C_2H_7N$ on treatment with nitrous acid gives a compound [B] having molecular formula $C_2H_6O$. [B] on treatment with an organic compound [C] gives a carboxylic acid [D] and a sweet smelling compound [E]. Oxidation of [B] with acidified potassium dichromate also gives [D]. [4]

(i) Identify [A], [B], [C], [D] and [E].

(ii) Write balanced chemical equation of [D] with chlorine in the presence of red phosphorus and name the reaction.

(c) Acetamide is amphoteric in nature. Give two equations to support this statement. [2]