(b) Explain SN2 reaction with mechanism and stereochemistry involved.

(c) What do you understand by Geometrical isomerism. Explain E/Z isomerism and draw the E/Z isomers of 1,2-dichloroethene. (5,5,5)

5. (a) Classify the following as electrophiles or nucleophiles. Justify your answer for SO_3, $:CCl_2$, BF_3, NH_3, H_2O.

(b) Show E1 and E2 mechanism with example. Differentiate between Hoffmann and Cope Elimination reaction.

(c) Explain why nitrobenzene directs the incoming electrophile to meta position. Draw the resonating structure to justify the answer. (5,5,5)

6. Write short notes on the following : (Any **Three**)

(i) Stability, Shape and hybridization of Free radical

(ii) Friedel Craft Alkylation

(iii) Ozonolysis of alkenes and alkynes

(iv) Nitration of benzene with mechanism. (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5045 **J**

Unique Paper Code : 2174001002

Name of the Paper : GE Basic Concepts of Organic Chemistry

Name of the Course : **All Undergraduate Courses Except with Chemistry Discipline**

Semester : II / IV / VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answer **four** questions in all.
3. Each question carries **15** marks.

1. Account for the following statements **(Any Five)**

   (a) Explain why Benzylamine is more basic than aniline

   (b) How does the solvent system effect the SN1 and SN2 mode of reaction?

   (c) Why addition of bromine to propene is anti-addition? Explain giving mechanism.

   (d) Write short notes on aromaticity and role of Huckle rule in aromaticity.

   (e) Clarify Racemic Mixture is optically inactive with example

   (f) What is electromeric effect? Explain with the help of suitable reaction. (3,3,3,3,3)

2. (a) Comment and discuss that 2,2,2-trifluoroethanol is much more acidic than ethanol with respect to dipole moment.

   (b) Explain Inductive effect and resonance effect. (Give at least four points of difference).

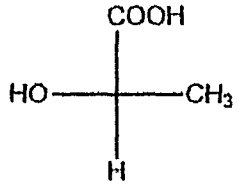
   (c) What is hyperconjugation effect? Explain the order of stability of primary, Secondary and tertiary carbocations on the basis of this effect.

   (5,5,5)

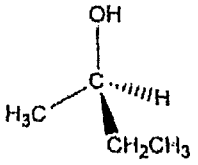
3. (a) Draw all the possible stereoisomers of 2,3-Dibromopentane in Fischer Projection. Comment on their optical activity and give the relationship between them. Designate erthyro and threo nomenclature to each stereoisomer.

   (b) Define chirality. How do you identify a chiral carbon in a compound? Explain with an example of 2-butanol.

   (c) Assign R/S to the following compounds (any **two**) and convert Fisher projection to Newman or vice versa.



(i)



(ii)

(5,5,5)

4. (a) How will you identify Markownikoff and anti-markownikoff addition in alkenes addition reaction. Explain with any suitable example in electrophilic addition of alkene.

6. (a) The experimental lattice energy of SnO_2 is -11596 Kjmol^{-1}. Calculate ΔH_f of SnO_2. Given $S_{(sn)} = 292$ KJ/mol, $D_{(02)} = 454$ KJ/mol, $I_{(Sn^{4+})} = 890$ KJ/mol and $E_{(O^{2-})} + 636$ KJ/mol.

(b) The dipole moment of H-X molecule is 1.92 D and bond distance is 1.20 Å. Calculate the ionic character of H-X.

(c) Discuss the toxicity of Lead. Give reasons of its toxicity. How can it be treated ?

5, 5, 5

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[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **5959** **I**

Unique Paper Code : 2172521201

Name of the Paper : DSC : Chemical Bonding and Elements in Biological System

Name of the Course : **B.Sc.(P) Life Sciences**

Semester : II

Time : 2 Hours ***Maximum Marks : 60***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt any **FOUR** questions.

(c) **All** questions carry equal marks.

1. (a) Define lattice energy and solvation energy. What is the role of these terms in deciding the solubility of ionic solids ?

(b) Based on the Molecular Orbital Theory, explain the paramagnetic and diamagnetic behaviour of B_2 and C_2.

(c) Explain the hybridization and give shapes of the following molecules : SF_6, NH_3 and PF_6.
5,5,5=15

2. (a) Explain, why the bond angles of H_2O, H_2S and H_2Se are different in the order $H_2O > H_2S > H_2Se$ despite having same geometry ?

(b) Draw the molecular orbital diagram of O_2 molecules and arrange the following in order to their increasing bond order, O_2, O_2^-, O_2^{2-}, O_2^+, and O_2^{2+} .

(c) Based on the Molecular Orbital Theory, explain, why He_2 molecule does not exist ?
5,5,5=15

4. (a) Using suitable examples, classify the essential and non – essential elements in an animal cell ?

(b) Elaborate on the mechanism and working of sodium – potassium pump. Discuss it's importance in regulating a cell.

(c) Draw the MO diagram of CO molecule. Discuss the bond strength of CO and CO^+.
5,5,5=15

4. (a) Explain the decreasing bond angle in the order $NO_2^+ > NO_2 > NO_2^-$ on the basis of VSEPR.

(b) Describe how Born – Haber Cycle is used for calculating lattice energy of NaCl.

(c) How calcium help in the process of blood clotting ? 5,5,5=15

5. (a) Explain Fajan's rules and on the basis of this rule compare the covalent character in the following compounds :

(i) NaCl and CuCl

(ii) AgCl and AgI

(b) (i) Explain, why the melting point of NaCl is higher than that of $AlCl_3$.

(ii) Why CuCl is insoluble while NaCl is soluble in water.

(c) Predict the type of hybridization and shape of the following species using Valance Bond Theory :

(i) CO_3^{2-}

(ii) XeF_2

(iii) ClF_3

(iv) H_2O

(v) IF_5 5, 5, 5 = 15

2588

(This question paper contains ..... printed pages.)

Name of Course: B.Sc. (Prog)

Semester: II

Name of the Paper: Core: Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I

Unique Paper Code: 42171205

Medium of setting the Question paper: English

Duration: 3 hours

Maximum Marks: 75

Instructions for Candidates

1. Section A and B are two parts given in paper, students should be asked to **attempt separately.**
2. Attempt any **THREE** questions each from Section A and Section B.
3. All questions carry 12.5 marks each.
4. Attempt all parts of a question together.

SECTION A

1. (a) What is the thermodynamic basis of Hess's law? Deduce the enthalpy change for the reaction:

$$2CH_4\,(g) \longrightarrow C_2H_6\,(g) + H_2\,(g)$$

(i) $2CH_4\,(g) + 2O_2\,(g) \longrightarrow CO_2\,(g) + 2H_2O\,(l)$ $\Delta H^O = -890.4$ KJ/mol

(ii) $C_2H_6\,(g) + 7/2\,O_2\,(g) \longrightarrow 2CO_2\,(g) + 3H_2O\,(l)$
$\Delta H^O = -1560.0$ KJ/mol

(iii) $H_2\,(g) + ½\,O_2\,(g) \longrightarrow H_2O\,(l)$ $\Delta H^O = -285.8$ KJ/mol

(b) Using bond energy data, compute ΔH_f^O for ethyl alcohol (C_2H_5OH).

Given:

ΔH^O (C-H) = 413 KJ.

ΔH^O (C-C) = 348 KJ.

ΔH^O (C-O) = 351 KJ.

ΔH^O (O-H) = 463 KJ

(c) Define integral heat of solution. Calculate the integral heat of solution of one mole HCl (g) in 100 H_2O (l), using the information that

ΔH_f^O (HCl) = -92.3 KJ

ΔH_f^O (HCl in 100 H_2O) = -168.0 KJ (4,4,4.5)

2. (a) Calculate the pH of a buffer solution obtained by mixing equal volumes of 0.02 M ammonium hydroxide and 0.04 M ammonium chloride.

Ks for ammonium hydroxide = 1.8×10^{-5}.

(b) The solubility of CaF_2 in water is 15.5×10^{-3} gdm^{-3} at a given temperature. Calculate its solubility product.

(c) What are acid-base indicators? What do you understand by the term 'pH range' of an indicator? Explain the action of phenolphthalein and methyl orange as indicators providing the reactions involved. (4,4,4.5)

3. (a) For a reaction $X_2 \longrightarrow 2X$, the equilibrium constant at 1225 K is 3.28×10^{-3} and the reaction is endothermic by 216.7 $KJmol^{-1}$. Calculate ΔG^O and ΔS^O for this reaction at 1225K.

(b) $N_2O_4 \rightleftharpoons 2NO_2$

Explain how this equilibrium reaction is affected by

(i) Increase of pressure and

(ii) Introduction of an inert gas

(c) (i) State and explain the law of mass action. Derive a relation between Kp and Kc for the reaction

$$2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_2\,(g)$$

(ii) Explain how the equilibrium constant changes with temperature. (4,4,4.5)

4. (a) Describe Ostwald's dilution law? What are its limitations.

(b) A mixture of nitrogen and hydrogen in the proportion of 1:3 by volume was subjected to a pressure of 30 atm and a temperature of 723K. After equilibrium was established, cooling and analysis indicated that the mixture contained 6% by volume of ammonia. Assume ideal behavior. Calculate Kp.

(c) Calculate the heat of formation of sucrose from the following data:

$$H_2\,(g) + \tfrac{1}{2}\,O_2\,(g) \longrightarrow H_2O(l) \qquad \Delta H = -285.8\ KJ$$

$$C\ (graphite) + O_2\,(g) \longrightarrow CO_2\,(g) \qquad \Delta H = -393.5\ KJ$$

$$C_{12}H_{22}O_{11}\,(s) + 12O_2\,(g) \longrightarrow 12CO_2\,(g) + 11H_2O\,(l) \qquad \Delta H = -5665\ KJ$$

(4,4,4.5)

SECTION B

1. (i) An organic compound (A) molecular formula $C_9H_{10}O$ forms 2,4-DNP derivatives (B), reduce tollens' reagent and undergoes Cannizzaro reaction forms compound (C). On vigorous oxidation it gives 1,2-benzenedicarboxylic acid. Identify A, B and C compounds.

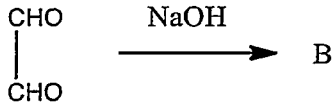
   (ii) How will you distinguish 1°, 2° and 3° alcohols?

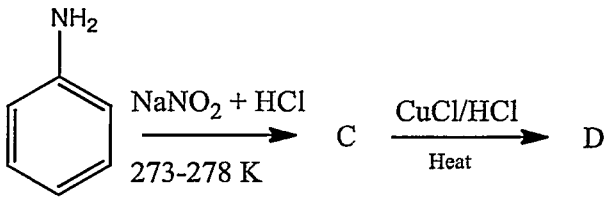
   (iii) Explain the difference between S_N1 and S_N2 mechanism.

   (4,4,4.5)

2. (i) Complete the following reactions:

   (a) $CH_3CH_2CH(OH)CH_3 \xrightarrow[\text{Heat}]{H_2SO_4} A$

   (b) 

   (c) 

   (ii) Carry out following conversion:

   (a) Phenol to Picric acid

   (b) Phenol to Salicylic acid

   (iii) Explain the importance of following test:

   (a) Tollen's test

   (b) Iodoform test

   (4,4,4.5)

3. (i) What are ambident nucleophiles? How can you convert alkyl halide into nitrile and isonitrile.

(ii) In benzyl halide and aryl halide, which one is more reactive for nucleophilic aromatic substitution reactions? Explain.

(iii) What is the importance of Wittig reaction and explain reaction and mechanism.

(4,4,4.5)

4. Write short notes on any **three** of the following

(i) Friedel-Craft's acylation

(ii) Pinacol-Pinacolone rearrangement

(iii) Gattermann-Koch reaction

(iv) Williamson's ether synthesis

(4,4,4.5)

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **5317**

Unique Paper Code : **2174001207**

Name of the Paper : **GE : Chemical Kinetics and Photochemistry**

Name of the Course : **All Undergraduate Courses except with Chemistry Discipline**

Semester : **II/IV/VI**

Duration : **2 Hours** Maximum Marks : **60**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *four* questions.

All questions carry equal marks.

Use of non-programmable scientific calculator is permitted.

1. (*a*) Distinguish between : 5

(*i*) Rate of a reaction and rate constant

(*ii*) Elementary and complex reactions.

(*b*) The reaction : 5

$$A + B \rightarrow \text{Products}$$

is a first order with respect to both A and B. Derive the integrated rate law when the initial concentration of both the reactants is not equal.

P.T.O.

(c) In a reaction, the reactant (X) is initially at 0.12 M. It is reduces to 0.06 M in 10 hours and 0.03 M in 20 hours. What is the order of the reaction and what is the rate constant and its units ? Write the differential rate equation also. 5

2. (a) Describe the Integrated rate method for determination of order of a reaction. 5

(b) For a reaction with differential rate : 5

$$\frac{dx}{dt} = k_n \left([A]_0 - x \right)^n .$$

Show that the half-life is given by :

$$t_{\frac{1}{2}} = \frac{1}{k_n (n-1)} \frac{2^{n-1} - 1}{[A]_0^{n-1}} .$$

(c) On what factors the rate and rate constant of a reaction depends ? Tabulate the units of rate constants for zero, first and second order reactions. 5

3. (a) Write the expression for Arrhenius equation and explain the terms involved in it. For the decomposition of acetone dicarboxylic acid, the rate constants are 2.46×10^{-5} s^{-1} at 273 K and 1.63×10^{-3} s^{-1} at 303 K. Calculate the activation energy. 5

(b) Write a comparison between Collision Theory of Bimolecular Reactions and Activated Complex Theory for Bimolecular Reactions. 5

(*c*) Define the steady state approximation applicable to reactive intermediates. Justify the approximation by taking a consecutive reaction as an example where the first step is the rate determining step. 5

4. (*a*) The photochemical decomposition of HI involves the following steps : 5

Primary process : $HI \xrightarrow{h\theta} H + I$

Secondary process : $H + HI \xrightarrow{k_2} H_2 + I$

$I + I \xrightarrow{k_3} I_2$.

Show that the quantum yield of the reaction is 2 initially but gradually reduces as the reaction progresses.

(*b*) What do you mean by primary and secondary processes of a photochemical reaction ? Enumerate the various ways by which an activated molecule can get deactivated after the primary process. 5

(*c*) Explain why increase in reactant concentration decreases the quantum yield of fluorescence. Why phosphorescence is also referred to as delayed fluorescence ? 5

5. (*a*) Define a photosensitized reaction and give an example. Explain the role of uranyl ion in the determination of number of photons in a chemical actinometer. 5

(*b*) Explain the phenomenon of photo stationary state. The proposed mechanism of photochemical dimerization of Anthracene (A) is given below :

Primary process : (*i*) $A \xrightarrow{h\theta} A^*$

Secondary process : (*ii*) $A^* + A \xrightarrow{k_2} A_2$

(*iii*) $A_2 \xrightarrow{k_3} 2A$

(*iv*) $A^* \xrightarrow{k_4} A + h\theta'$.

Derive the expression for the rate of formation of the dimer. 5

(*c*) Calculate the number of moles of HCl produced by the absorption of 1 Joule of radiant energy of wavelength 480 nm in the photochemical reaction between H_2 gas and Cl_2 gas to produce HCl, if the quantum yield of the reaction is 1×10^{-6}. 5

6. Write short notes on any *three* : 3×5

(*a*) Quenching of Fluorescence

(*b*) Half Life Method for order determination

(*c*) Order and molecularity of a reaction

(*d*) Graphical method for order determination.

This question paper contains 7 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **5815**

Unique Paper Code : **2172011203**

Name of the Paper : **Chemical Thermodynamics and its Applications**

Name of the Course : **B.Sc. (H) Chemistry**

Semester : **II**

Duration : **3 Hours** Maximum Marks : **90**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *six* questions in all.

Question No. 1 is compulsory.

Use of scientific calculators and log tables is allowed.

1. Answer the following questions (any *five*) : 5×3=15

(*a*) The entropy of crystalline ice is not zero at 0 K. Explain.

(*b*) Giving suitable examples, explain the meaning of endergonic and exergonic reactions.

P.T.O.

(*c*) The enthalpy of neutralization of a strong monoprotic acid with a strong monoprotic base is always constant. Explain.

(*d*) With the help of mathematical expressions, explain why ΔA is called "work function".

(*e*) Classify the following as extensive/intensive— Kinetic energy, Pressure, entropy, molar heat capacity, chemical potential, Temperature.

(*f*) To predict the spontaneity of a process both ΔS_{sys} and ΔS_{surr} are considered but ΔG alone is sufficient for the same. Explain.

(*g*) Define integral enthalpy of solution and dilution.

2. (*a*) Derive cyclic rule

$$\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T + 1 = 0$$

Prove it for $PV_m = RT$.

(*b*) With the help of suitable mathematical expression, discuss under what conditions heating and cooling effects are produced in the Joule Thomson experiment involving real gases. Define Inversion temperature and write down its expression for a real gas.

(*c*) Six moles of an ideal gas expands isothermally and reversibly from a pressure of 10 atm to 2 atm at 27°C. Calculate the values of q, w, ΔU and ΔH involved in the process. Will the values of heat and work be the same or different had the process been carried out irreversibly ? Why ? 5,5,5

3. (*a*) Write down the statement of Hess's law of constant heat summation and explain it with the help of an example. Is Hess's law valid for heat exchanged 'q' in a process ? Is it valid for entropy change 'ΔS' ? Give reason for your answer.

(*b*) Using the given data, calculate the enthalpy of formation of acetic acid :

(*i*) Enthalpy of sublimation of graphite = 718.39 kJ mol^{-1}

(*ii*) Enthalpy of dissociation of hydrogen gas = 435.97 kJ mol^{-1}

(*iii*) Enthalpy of dissociation of oxygen gas = 495.04 kJ mol^{-1}

Bond	**Bond enthalpy** (kJ mol^{-1})
C—C	347.69
C—H	413.38
C = O	728.02
C—O	351.46
O—H	462.75

P.T.O.

(*c*) Derive an expression for determination of variation of enthalpy of reaction with temperature. 5,5,5

4. (*a*) Describe Carnot cycle. A Carnot engine operates between 500 K and 250 K. If it absorbs 1000 J of heat from the hot reservoir, calculate the work done and efficiency.

(*b*) Define enthalpy of combustion. Calculate the enthalpy of formation of ethyl alcohol given the enthalpy of combustion of ethyl alcohol is -1381 kJ mol^{-1}, and enthalpy of formation of H_2O (*l*) and CO_2 (*g*) are -287 kJ mol^{-1} and -395 kJ mol^{-1} respectively.

(*c*) Show mathematically that the magnitude of the work involved in a reversible expansion of an ideal gas from volume V_1 and V_2 is larger than the corresponding work involved in an irreversible expansion against a constant pressure of P_2. 5,5,5

5. (*a*) Derive :

(*i*) $$\left(\frac{\partial S}{\partial P}\right)_T = -\frac{1}{\left(\frac{\partial T}{\partial V}\right)_P}$$

(*ii*) $$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P.$$

(*b*) State third law of thermodynamics. Absolute entropy of liquid water at 298 K has to be calculated. Write all the steps involved. Also write the final expression for calculation of entropy.

(*c*) Calculate the $\Delta_{mix}G$, $\Delta_{mix}S$ and $\Delta_{mix}H$ when 20 mol of an ideal gas A is mixed in 20 mol of ideal gas B, at 298 K and 1 atm pressure. 5,5,5

6. (*a*) Calculate $\Delta_r G$ for the following process : H_2O (l, 2 atm, 373 K) $\rightarrow$ H_2O (g, 2 atm, 373 K) where atm stands for atmospheric pressure.

(*b*) Derive the expression for the entropy of mixing for two ideal gases and show how it contributes to the spontaneity of the mixing process.

(*c*) Predict if ΔS_{sys} is positive, negative or zero in each of the following giving reason :

(*i*) NH_4NO_3 (s) + $3H_2$ (g) $\rightarrow$ $3H_2O$ (g) + N_2H_4 (g)

(*ii*) Crystallization of NaCl

(*iii*) Reversible adiabatic expansion of an ideal gas

(*iv*) 2 SO_2 (g) + O_2 (g) $\rightarrow$ 2 SO_3 (g)

(*v*) C (graphite) + $\frac{1}{2}O_2$ (g) $\rightarrow$ CO (g). 5,5,5

P.T.O.

7. (*a*) Show that $\Delta_r H = \Delta_r U + \Delta v_g RT$ for a chemical reaction involving gases. What will be the relation for condensed phases ?

(*b*) Partial molar volume of a component in a solution depends on the nature as well as the amount of the other components. Explain qualitatively.

(*c*) Derive the relations :

(*i*) $$\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$$

(*ii*) $$\left(\frac{\partial \mu_i}{\partial P}\right)_{T,n_j's} = V_{i,pm}.$$ 5,5,5

8. (*a*) Starting from $H = U + PV$ and first law of thermodynamics, derive the following expression for an ideal gas :

$$\Delta S = nC_{p;m} \ln \frac{T_2}{T_1} - nR \ln \frac{P_2}{P_1}.$$

(*b*) Explain the term escaping tendency. Prove that a substance will flow spontaneously from a region of higher chemical potential to a region of lower chemical potential.

(c) Calculate $\Delta_r G°$ for the following reaction at 300 K from the data provided :

$$2\ N_2O_5(g) \rightarrow 4\ NO_2(g) + O_2(g)$$

	N_2O_5	NO_2	O_2
$\Delta_f H°$/kJ mol^{-1}	11.3	33.18	0
$S°$/J K^{-1} mol^{-1}	355.7	240.06	205.14

Is the reaction spontaneous ? 5,5,5

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **5774**

Unique Paper Code : **2172011201**

Name of the Paper : **DSC : Chemistry of *s*- and *p*-Block Elements**

Name of the Course : **B.Sc. (H) Chemistry**

Semester : **II (UGCF-NEP)**

Duration : **3 Hours** Maximum Marks : **90**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *six* questions out of eight questions.

All questions carry equal marks.

1. Explain any *five* of the following :

   (*a*) Ionization energies of group 13 elements (B to Tl) show irregular trends.

   (*b*) IF_7 is always stored in pyrex glass bottles.

   (*c*) Oxygen exists as diatomic molecule while sulphur exists as S_8.

   (*d*) Behaviour of alkali metals in liquid ammonia.

   (*e*) Carbon shows maximum Catenation tendency than other elements of group 14 elements.

   (*f*) The increasing order of reducing character of Group 15 hydrides down the group. 5×3

P.T.O.

2. (*a*) What are interhalogen compounds ? Draw the structure of ClF_3 and ICl_3 in solid state.

(*b*) Discuss Van Arkel-De Boer process for the purification of metals Ti, Zr, V and Th. Write the chemical equations involved.

(*c*) Explain briefly :

(*i*) Helium and Neon do not form Clathrate compounds.

(*ii*) Why does Li form oxides whereas Na form peroxides and other elements of the 1st Group form superoxides on heating in air ? 3×5

3. (*a*) Describe the Hydrometallurgical process or cyanide process for the extraction of silver and gold. Write the chemical equations involved during extraction.

(*b*) Discuss the structure and bonding behaviour in B_2H_6 molecule. Write the reactions of diborane with H_2O and NH_3 :

(*i*) $B_2H_6 + H_2O \longrightarrow$

(*ii*) $B_2H_6 + NH_3 \xrightarrow{\Delta}$

(*c*) Nitrogen is chemically inert while phosphorus is quite reactive, explain. Discuss about the allotropes of phosphorus. 3×5

4. Attempt any *five* of the following :

(*a*) Why F_2 is strongest oxidizing agent though electron affinity of Cl_2 is more ?

(*b*) Describe the order of stability of hydrides of group 14 elements (CH_4, SiH_4, GeH_4 and SnH_4) towards water.

(*c*) Arrange in the order of increasing oxidising power and acidic strength of $HClO$, $HClO_2$, $HClO_3$ and $HClO_4$? Give reasons.

(*d*) Explain the characteristic properties of alkali and alkaline earth metals towards flame colouration.

(*e*) Explain the structure and bonding behaviour in basic beryllium acetate.

(*f*) What are allotropes ? What is the basic difference between diamond and graphite ? 5×3

5. Attempt any *five* of the following :

(*a*) H_2O is a liquid while H_2S is gas. Explain.

(*b*) Give the structure and the name of the product formed when two molecules of H_3PO_4 (ortho phosphoric acid) condensed to each other.

(*c*) Explain the structure of XeF_2 on the basis of MOT.

(*d*) Beryllium shows anomalous behaviour and dissimilarities with other alkaline earth metals. Explain with *three* suitable examples.

(*e*) Arrange the following in increasing order of their boiling points and justify :

$$HF,\ NH_3,\ H_2O,\ CH_4.$$

(*f*) BaO is more soluble than MgO but $BaSO_4$ is insoluble, however $MgSO_4$ is quite soluble in water. Explain. 5×3

6. (*a*) Explain the diagonal relationship between Boron and Silicon. Explain with the help of electronegativity concept and polarising power concept.

(*b*) What are Clathrates compounds ? What are the conditions for the formation of Clathrates compounds ? Discuss the type and preparation of Gas hydrate and quinol based Clathrates compounds.

(*c*) What are crown ethers ? Write the structure of crown-4 with lithium ion and crown-6 with potassium ion. 3×5

7. Attempt any *five* of the following :

(*a*) Draw the structure of Mg-EDTA complex.

(*b*) What is inert pair effect ? Sb^{3+} is reducing in nature and Bi^{3+} is stable. Explain.

(*c*) Arrange the following in increasing order of boiling points :

NH_3, PH_3, AsH_3 and SbH_3.

(*d*) Give the structure of peroxydisulphuric acid and also the products obtained on its hydrolysis.

(*e*) Alkali metals are strong reducing agents. Explain.

(*f*) Why is SCl_6 not known but SF_6 is a known compound ? 5×3

8. Write short notes on any *three* :

(*a*) Allotropes of Sulphur

(*b*) Pseudo halogens

(*c*) Ellingham diagrams for the reduction of metal oxides

(*d*) 2, 2, 2-cryptand for potassium ion. 3×5

This question paper contains **5** printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **5795**

Unique Paper Code : **2172011202**

Name of the Paper : **DSC : Haloalkanes, Arenes, Haloarenes, Alcohols, Phenols, Ethers and Epoxides**

Name of the Course : **B.Sc. (Hons.) Chemistry**

Semester : **II**

Duration : **2 Hours** Maximum Marks : **60**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *four* questions in all.

Question No. **1** is compulsory.

Each question carries **15** marks.

1. Answer the following (any *five*) :

   (*a*) Arrange the following alkoxide nucleophiles in decreasing order of S_N2 reactivity giving reasons :

   Me_3CO^-, MeO^-, Me_2CHO^-.

   (*b*) Why is nitrobenzene a suitable solvent for the Friedel-Crafts alkylation of PhBr while benzene is not ?

   (*c*) Which is a stronger base, RO^- or RS^- ? Which will be a better nucleophile in aqueous solution and DMSO ?

P.T.O.

(*d*) How many mononitration products would be formed from each isomeric dibromobenzene ?

(*e*) Comment on acidic properties of isomeric nitrophenols.

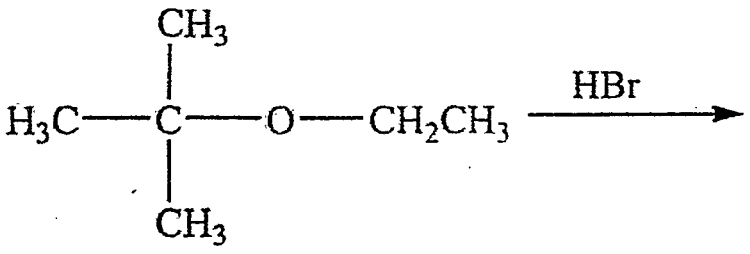
(*f*) Why do aryl halides and vinyl halides show low reactivity towards nucleophilic substitution reactions compared to alkyl halides ?

(*g*) How many molecules of HIO_4 would be consumed for oxidation of propane-1, 2, 3-triol and what are the products formed ?

(*h*) Giving reasons, arrange the following in increasing order of reactivity towards alkaline hydrolysis by S_N1 reaction :

CH_3Cl, Ph_2CHCl, Ph_3CCl, $PhCH_2Cl$. 3×5=15

2. (*a*) Write the product of the following reaction with mechanism :



(*b*) Why 2, 4, 6-trinitrochlorobenzene is easily hydrolysed in the presence of aq. NaOH solution but not chlorobenzene ?

(*c*) The reaction of $(CH_3)_3$-C-Cl with CH_3O^- does not give of $(CH_3)_3$-C-OCH_3. 5,5,5

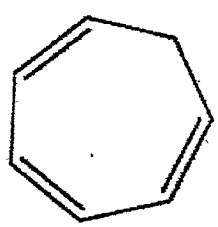
3. (*a*) What happens when tertiary butyl bromide is treated with water ? Give its mechanism with stereochemical aspect.

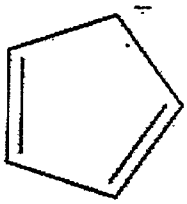
(*b*) How would you distinguish between the following by a chemical reaction :

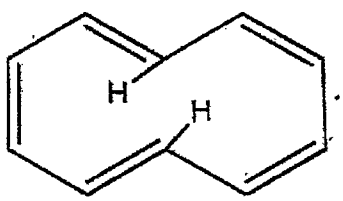
(*i*) 1-butanol and diethyl ether

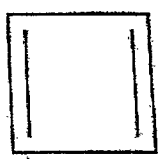
(*ii*) tert-butyl alcohol and methanol.

(*c*) Classify the following compounds as aromatic, antiaromatic and non-aromatic ?









5,5,5

4. (*a*) Outline the following conversions (any *three*) :

(*i*) Benzyl alcohol from methanal

(*ii*) Salicylic acid from phenol

(*iii*) Acetone from methyl bromide

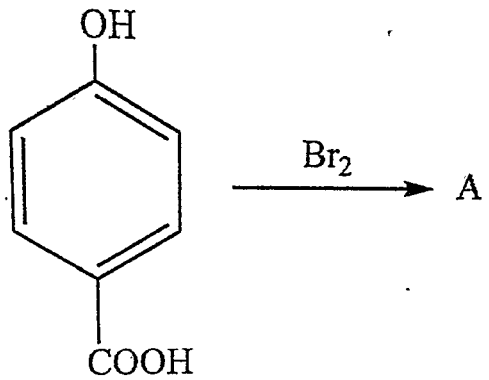
(*iv*) Benzene to *m*-bromobenzoic acid.

(*b*) Both o-bromoanisole and m-bromoanisole give the same product on reaction with $NaNH_2$ in the presence of liquid ammonia. 9,6

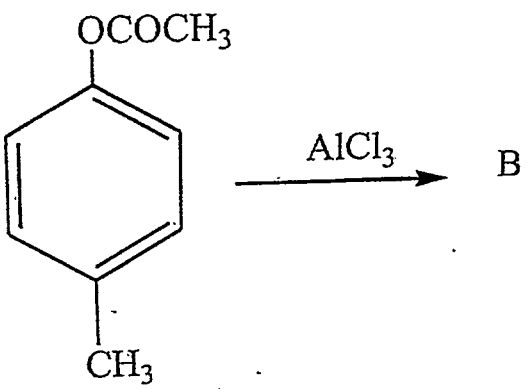
P.T.O.

5. Complete the following reactions : 15

(*i*)

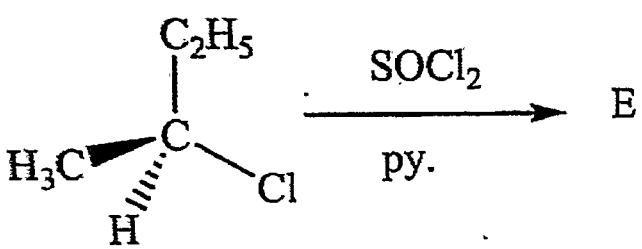


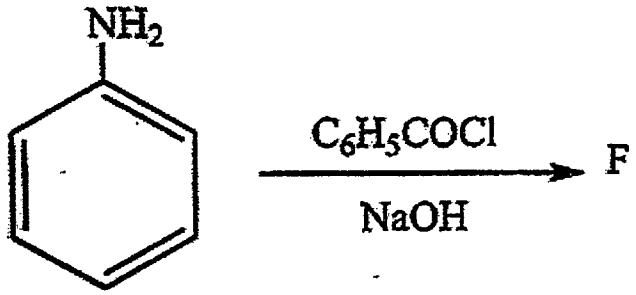
(*ii*)

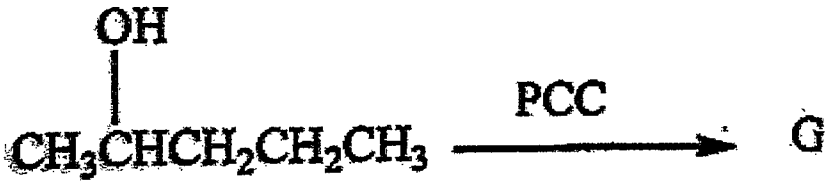


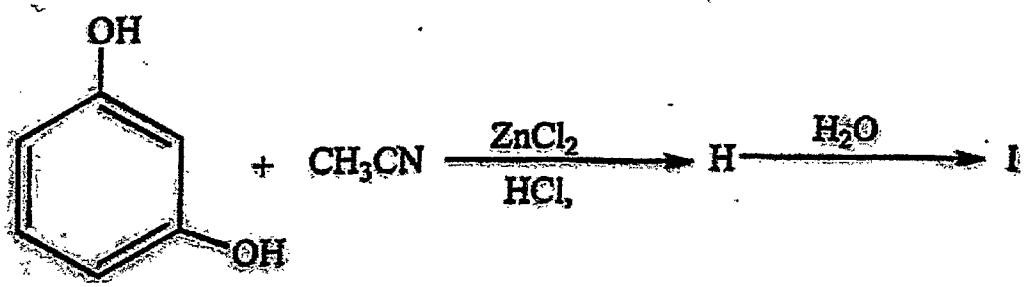
(*iii*) $CO_2 + CH_3CH_2MgBr \longrightarrow C \xrightarrow{H_3O^+} D$

(*iv*)



(v) 

(vi) 

(vii) 

6. Write short notes on (any *three*) :

(*i*) Oppenauer oxidation

(*ii*) Claisen rearrangement

(*iii*) Pinacol Pinacolone rearrangement

(*iv*) Friedel-Crafts reaction. 5,5,5

(b) Explain giving reasons :

(i) The enthalpies of atomization of transition metals are high.

(ii) The transition metals generally form colored compounds.

(c) How is the variability in oxidation states of transition metals different from that of the non-transition metals? Illustrate with examples.

(5,5,5)

5. (a) Draw a MO diagram of Nitric oxide (NO).

(b) Why in SF6, all the S-F bonds are equal, while in PF_5, all the P-F bonds are not equal.

(c) Explain why silver halides are least soluble in water, though their lattice is almost of the same order as that of highly soluble alkali metal halides.

(5,5,5)

6. Write short notes on **(Any three)** of the following :

(i) Magnetic properties of transition metals

(ii) Hydrogen bonding

(iii) Solvation energy

(iv) Van der Waal's forces (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5958 **J**

Unique Paper Code : 2172521202

Name of the Paper : DSC: Periodic Properties and Chemical Bonding

Name of the Course : **B.Sc. (Prog.) PS/AC/IC**

Semester : II

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions out of the **six** questions.
3. **All** questions carry **15** marks each.
4. Attempt **all** parts of a question together.

1. (a) The expected electronic configurations of Cr and Cu are different from the observed electronic configurations. Explain.

   (b) Explain the trend of first ionization enthalpies for second-period elements of the periodic table.

   (c) How does metallic bonding affect the enthalpy of atomization in s-block elements? (5,5,5)

2. (a) Using MOT, explain why N_2 has greater dissociation energy than N_2^+, whereas O_2 has lower dissociation energy than O_2^+?

   (b) Draw the Born-Haber cycle for $MgBr_2$ and calculate the lattice energy of $MgBr_2$ from the following data :

   (i) Heat of sublimation of magnesium =148 kJ/mol

   (ii) Heat of vaporization of Br_2 (l) = 31 kJ/mol

   (iii) Dissociation energy of Br_2 (g) =193 kJ/mol

   (iv) Ionization energy of magnesium Mg/Mg^{2+} = 2187 kJ/mol

   (v) Electron gain enthalpy of bromine = –331 kJ/mol

   (vi) Heat of formation of magnesium bromide ($MgBr_2$) = –524 kJ/mol

   (c) Define polarizing power. Which cation has greater polarizing power in the following pairs?

   (i) Na^+ and Mg^{2+}

   (ii) Cu^{2+} and Ca^{2+} (5,5,5)

3. (a) Define the term resonance and draw the resonating structures of nitrate ion and carbonate ion.

   (b) Based on VSEPR theory, explain the structures of the following **(any two)** :

   (i) NH_3

   (ii) I_3^-

   (iii) ClF_3

   (c) Calculate the % ionic character of the HF molecule. The bond length of H-F is 0.917×10^{-10} m and the observed dipole moment of HF molecule is 6.6×10^{-30} C.m. (Electronic charge = 1.602×10^{-19} C). (5,5,5)

4. (a) $PbCl_4$ is less stable than $SnCl_4$ but $PbCl_2$ is more stable than $SnCl_2$, why?

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **5926**

Unique Paper Code : **2173522005**

Name of the Paper : **DSE : Acids & Bases and Aqueous Chemistry of Metal Ions**

Name of the Course : **Bachelor of Science Life Science with Chemistry**

Semester : **IV**

Duration : **2 Hours** Maximum Marks : **60**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *four* questions.

Each question carries equal marks.

1. (*a*) Answer the following multiple-choice questions :

(1) Solvent levelling occurs because :

(*a*) Solvent limits the strength of acids and bases

(*b*) All acids and bases behave the same way in water

(*c*) Water reacts differently to acids and bases

(*d*) None of the above

P.T.O.

(2) Super acids are stronger than :

(*a*) H_2SO_4

(*b*) HCl

(*c*) H_3O^+

(*d*) All of the above

(3) A buffer solution maintains pH because :

(*a*) It consists of a weak acid and its conjugate base

(*b*) It contains only strong acid

(*c*) It neutralizes water

(*d*) None of the above

(4) The Henderson-Hasselbalch equation is used to :

(*a*) Calculate pH of buffer solutions

(*b*) Determine ionization energy

(*c*) Find atomic radius

(*d*) Analyze oxidation states

(5) Which buffer is commonly used in biological processes ?

(*a*) NaOAc/HOAc

(*b*) Boric acid and borate

(*c*) Phosphate buffer

(*d*) Universal buffer

(*b*) Discuss the significance of oxo acids, hydroxo acids and aqua acids in acid-base chemistry.

(*c*) Define buffer capacity and explain its significance in maintaining pH stability. 5,5,5

2. (*a*) Define hard and soft acids and bases (HSAB principle) and illustrate their importance with examples.

(*b*) Derive the Henderson-Hasselbalch equation and explain its use in pH calculations.

(*c*) Define superacids and superbases and explain their applications. 5,5,5

3. (*a*) What is solvent leveling ? How does it influence acid-base behavior ?

(*b*) Explain the importance of acetate buffers (NaOAc/HOAc) in chemical and biological applications.

(*c*) Describe the role of buffers in maintaining physiological pH in biological systems. 5,5,5

4. (*a*) Describe the trends in standard potentials and their significance in redox reactions.

(*b*) Explain how dichromate titrations are used in analytical chemistry.

(*c*) Describe the applications of precipitation in the separation of metal ions. 5,5,5

5. (*a*) Discuss the role of disproportionation in redox stability.

(*b*) Explain the significance of Latimer diagrams in predicting redox behavior.

(*c*) How does complexation stabilize oxidation states such as Cu(I) and Mn(III) ? 5,5,5

6. (*a*) Discuss examples of biologically relevant redox reactions.

(*b*) Describe the role of metalloenzymes in biological systems.

(*c*) Discuss the precipitation reactions involving halides, OH^- and $C_2O_4^{2-}$. 5,5,5

(b) Explain SN2 reaction with mechanism and stereochemistry involved.

(c) What do you understand by Geometrical isomerism. Explain E/Z isomerism and draw the E/Z isomers of 1,2-dichloroethene. (5,5,5)

5. (a) Classify the following as electrophiles or nucleophiles. Justify your answer for SO_3, $:CCl_2$, BF_3, NH_3, H_2O.

(b) Show E1 and E2 mechanism with example. Differentiate between Hoffmann and Cope Elimination reaction.

(c) Explain why nitrobenzene directs the incoming electrophile to meta position. Draw the resonating structure to justify the answer. (5,5,5)

6. Write short notes on the following : (Any **Three**)

(i) Stability, Shape and hybridization of Free radical

(ii) Friedel Craft Alkylation

(iii) Ozonolysis of alkenes and alkynes

(iv) Nitration of benzene with mechanism. (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5045 **J**

Unique Paper Code : 2174001002

Name of the Paper : GE Basic Concepts of Organic Chemistry

Name of the Course : **All Undergraduate Courses Except with Chemistry Discipline**

Semester : II / IV / VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answer **four** questions in all.
3. Each question carries **15** marks.

1. Account for the following statements **(Any Five)**

   (a) Explain why Benzylamine is more basic than aniline

   (b) How does the solvent system effect the SN1 and SN2 mode of reaction?

   (c) Why addition of bromine to propene is anti-addition? Explain giving mechanism.

   (d) Write short notes on aromaticity and role of Huckle rule in aromaticity.

   (e) Clarify Racemic Mixture is optically inactive with example

   (f) What is electromeric effect? Explain with the help of suitable reaction. (3,3,3,3,3)

2. (a) Comment and discuss that 2,2,2-trifluoroethanol is much more acidic than ethanol with respect to dipole moment.

   (b) Explain Inductive effect and resonance effect. (Give at least four points of difference).

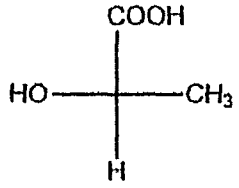
   (c) What is hyperconjugation effect? Explain the order of stability of primary, Secondary and tertiary carbocations on the basis of this effect.

   (5,5,5)

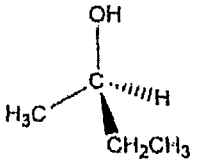
3. (a) Draw all the possible stereoisomers of 2,3-Dibromopentane in Fischer Projection. Comment on their optical activity and give the relationship between them. Designate erthyro and threo nomenclature to each stereoisomer.

   (b) Define chirality. How do you identify a chiral carbon in a compound? Explain with an example of 2-butanol.

   (c) Assign R/S to the following compounds (any **two**) and convert Fisher projection to Newman or vice versa.



(i)



(ii)

(5,5,5)

4. (a) How will you identify Markownikoff and anti-markownikoff addition in alkenes addition reaction. Explain with any suitable example in electrophilic addition of alkene.

(b) Friedlander synthesis for Quinoline

(c) Hantzsch synthesis for pyrrole

(d) Doebner-Miller synthesis of quinoline (5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5586 **J**

Unique Paper Code : 2172012402

Name of the Paper : DSC: Carbohydrates, Lipids and Heterocyclic Compounds

Name of the Course : **B.Sc. (Hons)**

Semester : IV

Duration : 3 Hours Maximum Marks : 90

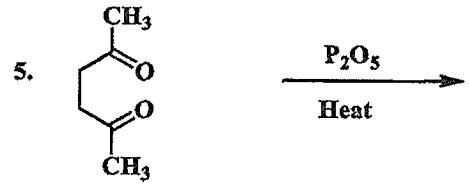
Instructions for Candidates

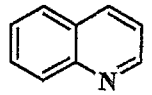
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **six** questions in all.
3. **All** questions carry equal marks.

1. (a) An aldopentose(**A**) gives an optically active aldaric acid (**B**). (**A**) on Ruffs degradation gives an aldotetrose (**C**) which can be oxidised to an optically inactive aldaric acid (**D**). Give the reactions involved, structure and names of (**A**) (**B**) (**C**) and (**D**).

(b) When crystals of pure α - D-glucose are dissolved in water, the specific rotation gradually changes from + 112.2 to + 52.7. When crystals of pure β-D-glucose are dissolved in water, the specific rotation gradually changes from + 18.7 to + 52.7. Name the phenomena involved and discuss its mechanism. Explain why this phenomenon is faster in 2-hydroxypyridine as compared to that in a mixture of phenol and pyridine.

(c) Convert D-arabinose to D-glucose & D-mannose. Name the reaction involved in it. (5,5,5)

5. 

6 

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(b) How will you carry out the following conversions?

(i) 3-Bromopyridine from pyridine

(ii) Thiophane from acetylene

(iii) Piperidine from pyridine

(iv) Furfural from furan (1×7,2×4)

8. Write short notes on (**Any three**) :

(a) Paal-Knorr synthesis for thiophene

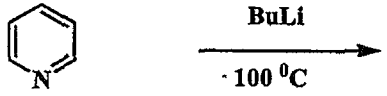
(b) How will you synthesise quinoline by Skraup synthesis? Explain with the help of a suitable mechanism.

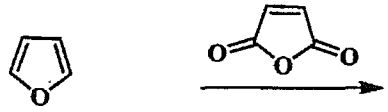
(c) Explain the following :

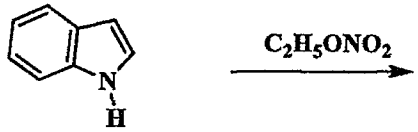
(i) Compare pyrrole and pyridine based on basicity.

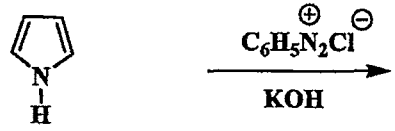
(ii) Discuss the aromaticity of thiophene and compared it with benzene. (5,5,2.5×2)

7. (a) Complete the following reactions :

1. 

2. 

3. 

4 

2. (a) Explain Inter-conversion of D-glucose, D-mannose and D-fructose in a basic solution.

(b) Give Haworth proof (using Fisher Projection) for cyclic structure of D-glucose.

(c) Carry out the following conversions (give complete reaction involved in it) :

(i) D-glucose to n-hexane

(ii) D-glucose to sorbitol

(iii) D-fructose to 2-methyl hexanoic acid

(5,5,5)

3. (a) An unknown disaccharide gives a positive Tollens' test. A glycosidase hydrolyses it to D-galactose and D-glucose. When the disaccharide is treated with methyl iodide (excess) and Ag_2O and then hydrolysed with dilute HCl, the products are 2,3,4,6-tetra-O-methylgalactose and 2,3,6-tri-O-methylglucose. Give structure and name of the disaccharide. Give complete reaction.

P.T.O.

(b) Compare the structure of sucrose & maltose based on composition, reducing nature, type of bonding, nature of anomeric carbon.

(c) What are polysaccharides? Give two differences between starch and cellulose based on monosaccharide units present & glycosidic linkage? Write the Haworth projection of cellulose.

(5,5,5)

4. (a) Define Iodine value of an oil. Draw the structure of glyceryl trioleate and calculate its iodine value.

(b) What are glycolipids? Write the structure of a glycolipid derived from one molecule each of spingosine, palmitic acid and α-D-glucose.

(c) Differentiate between :

(i) fats and oils

(ii) ω - 3 & ω - 6 fatty acids (give example)

(5,5,5)

5. (a) Explain electrophilic substitution in quinoline takes place more readily at the benzene ring rather than the pyridine ring. At which position electrophilic substitution take place.

(b) Explain Why is pyridine more reactive towards nucleophilic substitution compared to benzene? What product forms when pyridine reacts with sodamide? Explain using chemical reactions.

(c) Explain the following :

(i) Why nitration and sulphonation reactions of furan are carried out under mild conditions.

(ii) Why pyridine does not show Friedel-Craft reactions. (5,5,2.5×2)

6. (a) Arrange pyrrole, furan and thiophene in order of their reactivity towards electrophilic substitution reactions. Explain and justify by drawing suitable structures.

(iii) Write the product formed when primary, secondary and tertiary aliphatic amine react with nitrous acid.

(iv) How is ethylamine prepared by Gabriel phthalimide synthesis. (4,4,4,3)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5861 **J**

Unique Paper Code : 2172512401

Name of the Paper : DSC- Chemistry of Carboxylic Acids & their Derivatives, Amines and Heterocycles

Name of the Course : **B.Sc. (Prog.)**

Semester : IV

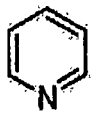
Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll. No. on the top immediately on receipt of this question paper.
2. Attempt any four questions, all questions carry equal marks:

1. (i) Identify the name of the reaction and write the product:

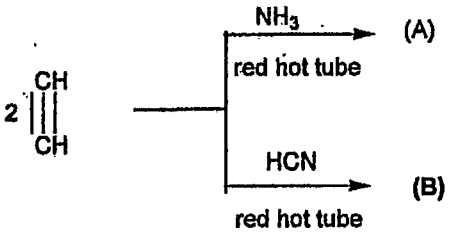
(a) $CH_3CH_2CH_2CH_2COOH \xrightarrow[(ii)\ H_2O]{(i)\ Br_2,\ P}$

(b)  $\xrightarrow{NaNH_2,\ NH_3}$

(ii) How will you distinguish between primary, secondary and tertiary amines by Hinsberg test. Explain with reactions.

(iii) Give a comparison between Hofmann elimination and Saytzef elimination, with suitable example.

(iv) Write the structure of A, B and C.



(b) What is sulfanilic acid. Give its method of preparation.

(iv) What is carbylamine reaction. Write the chemical reaction and give its use. (4,4,4,3)

6. (i) What is Hofffmann degradation reaction. Give its mechanism.

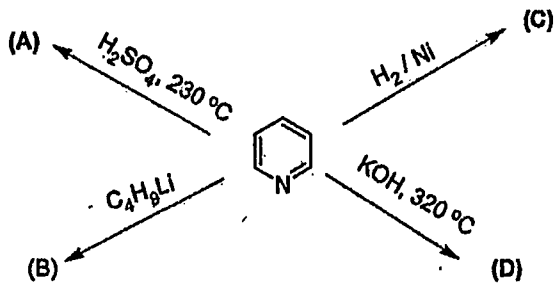
(ii) What is the order of basicity of CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$ in aqueous medium. Explain on the basis of inductive and solvation effects.

(iv) Pyrrole undergoes coupling reaction with benzene diazonium salt whereas pyridine does not. Explain.

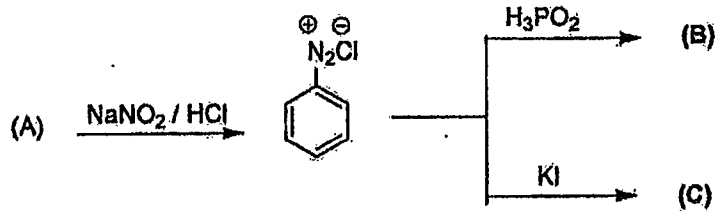
(4,4,4,3)

5. (i) Furan undergoes Diels Alder reaction. Explain why with suitable example.

(ii) Write the structure of products A, B, C and D in the following reactions of pyridine:



(iii) (a) Write the product A and B obtained when two moles of acetylene treated with either ammonia or HCN.



(4,4,4,3)

2. (i) Give reason for the following:

(a) Trichloroacetic acid is stronger acid than acetic acid.

(b) Alkaline hydrolysis of esters is preferred over acidic hydrolysis for preparation of carboxylic acids.

(ii) Differentiate between the keto and enol form of ethylacetoacetate. How are they isolated.

P.T.O.

(iii) What is Claisen condensation. Give its mechnism.

(iv) Pyrrole undergoes electrophilic substitution reactions at C-2. Explain why. (4,4,4,3)

3. (i) What is Perkin condensation. Write its mechanism.

(ii) Arrange the following in increasing order of reactivity towards nucleophilic reaction give reason for the same.

RCOOH $(RCO)_2O$ RCOOR' RCOCl

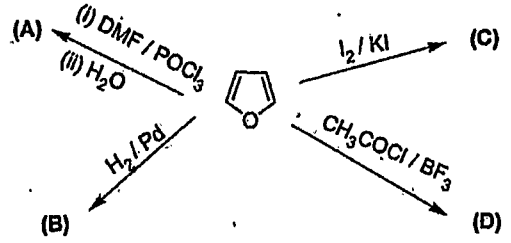
(iii) Convert

(a) Acetyl chloride to t-butyl alcohol

(b) Ethylacetoacetate to 2-methylbutanoic acid

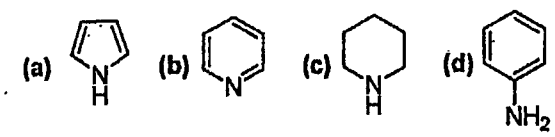
(iv) Write the syntheis of 3-chloropyridine from pyrrole using dichlorocarbene. (4,4,4,3)

4. (i) Write the structure of A, B, C and D in the following reactions of furan:



(ii) What is the order of aromaticity of furan, thiophene and pyrrole. Give reason for this.

(iii) Arrange in increasing order of basicity. Give reason for it.



P.T.O.

(c) How will you differentiate between the terminal CO and bridging CO?

(d) Complexes with chelating ligands are more stable than the complexes with non-chelating ligands. Explain, with a suitable example. (5,4,3,3)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4653 **J**

Unique Paper Code : 2174001203

Name of the Paper : GE: Coordination and Organometallic Compounds

Name of the Course : **All Undergraduate Courses Except with Chemistry**

Semester : II / IV / VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions.
3. **All** questions carry equal marks.

1. (a) For Mn^{3+} ion, mean pairing energy P is found to be 28000 cm^{-1}, Δ_o values for the complex $[Mn\ (H_2O)_6]^{3+}$ and $[Mn\ (CN)_6]^{3-}$ are 21000 and 38500 cm^{-1} respectively. Do these complexes have low spin or high spin configuration? Also write down the configuration corresponding to these states.

(b) What is meant by synergic effect? How does it account for the formation of carbonyl complexes of transition metals in low oxidation states.

(c) Ni (II) is stabilized in the formation of square planar rather than octahedral geometry in the presence of strong field ligands. Explain why?

(d) Predict whether the following obey EAN rule and explain

H Mn $(CO)_5$, $[Co\ (CO)_3(\eta^3\text{-}C_3H_5)]$, $Rh_2(CO)_4Cl_2$

(5,4,3,3)

2. (a) Discuss how does CO behave as σ donor and π acceptor, through carbon atom in metal carbonyls, with reference to MO diagram.

(d) Define Jahn-Teller theorem. Giving reasons, explain in which case this effect would be observed?

$t_{2g}^3 e_g^1$ or $t_{2g}^6 e_g^2$ (5,4,3,3)

6. (a) How will you rationalise the increase in C-C bond length from 133.7 pm in ethene to 137.5 pm in Ziese's salt, accompanied by a decrease in C-C stretching frequency from 1623 cm-1 to 1526 cm–1?

(b) Give the IUPAC names of the following complexes **(any four)** :

(i) $K_4[Fe\ (CN)_6]$

(ii) $[Cr\ (ONO)(NH_3)_2Br_2H_2O]$

(iii) $[Co\ (NH_3)_5Cl]\ Cl_2$

(iv) $Na_2[ZnCl_4]$

(v) $K_2\ [OsNCl_5]$

(ii) $[Rh(NH_3)_6]^{3+}$ and $[Co(NH_3)_6]^{3+}$

(5,4,3,3)

5. (a) Write chemical formulae for the following compounds :

(i) Ammonium tris(oxalato)cobaltate (III)

(ii) Potassium oxidotetrafluoridochromate (V)

(iii) Dichlorido bis(triphenylphosphine) nickel (II)

(iv) Tetrachlorido 1,2-diaminoethane platinum (IV)

(v) Hexaammine cobalt (III) hexacyanidochromate (III)

(b) Draw the structures for the following :

$Fe_2(CO)_9$, $Re_2(CO)_{10}$, $Fe(CO)_5$, $Co_2(CO)_8$

(c) Which of the following are not organometallic compounds and why?

$[K_2Zn(CN)_4]$, $(C_2H_5)_4Pb$, Me_4Sn, $B(OCH_3)_3$

(b) Draw the orbital splitting diagram for tetrahedral $[CoCl_4]^{2-}$ and give its electronic configuration. Calculate its CFSE.

(c) What are homoleptic carbonyls? Give two examples.

(d) The magnetic moment for $[MnBr_4]^{2-}$ and $[Mn(CN)_6]^{3-}$ are 5.9 and 2.8 BM respectively. Give the hybridisation, geometry of each complex on the basis of VBT. (5,4,3,3)

3. (a) On the basis of VBT answer the following questions for the six coordinated complex ion: $[Fe(CN)_6]^{3-}$

(i) What is the oxidation state of Fe?

(ii) What type of hybridization is involved?

(iii) State whether the given complex is inner or outer orbital complex.

P.T.O.

(iv) What is the magnetic behaviour of the complex ion?

(v) Calculate the value of magnetic moment.

(b) CO_2CO_8 (s) shows IR stretching frequencies at two different regions, 2100-2000 cm^{-1} and 1850-1880 cm^{-1}. However, in $Mn_2(CO)_{10}$ all CO stretching frequencies are observed in one region at 2100 cm^{-1}. Predict their structure based on the results of IR data.

(c) Explain the increasing Δ_o values observed in case of the following :

Complex	Δ_o (cm^{-1})
$[Co(NH_3)_6]^{3+}$	23000
$[Rh(NH_3)_6]^{3+}$	34000
$[Ir(NH_3)_6]^{3+}$	41000

(d) What are π-acid ligands? Illustrate with one suitable example. (5,4,3,3)

4. (a) Discuss the structure of the following :

(i) Methyl Lithium

(ii) Ferrocene in solid and gaseous phase

(b) The complex ion $[Ni(H_2O)_6]^{2+}$ is a regular octahedral but $[Cu(H_2O)_6]^{2+}$ is distorted octahedral. Explain why.

(c) Using the 18 electron rule as a guide, identify/ find

(i) The 3d metal in $[\eta^5\text{-}C_5H_5)\ M\ (C_2H_4)_2]$

(ii) The probable number of carbonyl ligands in $[W(\eta^6\text{-}C_6H_6)\ (CO)_n]$.

(iii) The number of Ru-Ru bonds in $[Ru_3(CO)_{12}]$

(d) Which complex in each of the following pairs will have greater crystal field splitting and why

(i) $[Fe(C_2O_4)_3]^{4-}$ and $[Fe(C_2O_4)_3]^{3-}$

(b) Macrocyclic Effect

(c) Werner's theory of Coordination Compounds

(d) Factors affecting stability of the complexes

(5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5526 **J**

Unique Paper Code : 2172012401

Name of the Paper : DSC 10: Coordination Chemistry and Reaction Mechanism

Name of the Course : **B.Sc. (Hons) Chemistry (NEP-UGCF-2022)**

Semester : IV

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **six** questions in all.
3. Question **1** is mandatory.
4. **All** questions carry equal marks.

P.T.O.

1. Explain the following giving appropriate reasoning :

   (a) 4d and 5d elements form low spin octahedral complexes.

   (b) Square planar complexes do not exhibit optical isomerism.

   (c) $[PtF_6]$ is stable, whereas NiF_6 does not exist.

   (d) Fe(II) and Fe(III) form complexes with CN^- but not with NH_3.

   (e) The crystal field splitting in tetrahedral complexes is smaller than in octahedral complexes.

   (3,3,3,3,3)

2. (a) Name the following complexes according to the IUPAC system of nomenclature.

   (i) $[Pt(NH_3)_4]\ [PtCl_4]$

   (c) The formation of $[CdBr_4]^{2-}$ from $[Cd(H_2O)_6]^{2+}$ exhibits the successive equilibrium constants K_1, K_2, K_3 and K_4 as 1.56, 0.54, 0.06 and 0.37, respectively. Explain why K_4 is larger than K_3.

   (5,5,5)

7. (a) Cr(II) fluoride and Mn(II) fluoride, both have a central metal ion surrounded by six F-ions. The Mn-F bond lengths are equidistant but four of the Cr-F distances are long and two are short. Explain.

   (b) What are labile and inert complexes? Explain giving one example each, on the basis of CFT.

   (c) Differentiate between inner orbital and outer orbital octahedral complexes. (5,5,5)

8. Write short notes on **(Any three)** :

   (a) Crystal Field theory and its limitations

(b) Describe the factors responsible for strong distortion in the octahedral complexes. Square planar complexes are a special case of octahedral geometry. Justify your answer.

(c) (i) I^- and CO have higher trans effects than Cl^-. Explain.

(ii) Predict the products when $[PtCl_4]^{2-}$ is treated with NH_3 followed by C_2H_4. (5,5,5)

6. (a) On the basis of VBT, account for the magnetic properties of $[Ni(NH_3)_6]^{2+}$ and $[Cr(CN)_6]^{3-}$.

(b) Determine the CFSE of a d^6 octahedral complex having 10Dq = 25000 cm^{-1} and P = 15000 cm^{-1} (mean pairing energy).

(ii) $K_3[Fe(CN)_6]$

(iii) $[Co(NH_3)_3(NO_2)_3]$

(iv) $[(H_3N)_5Co\text{-}NH_2\text{-}Co(NH_3)_4(H_2O)]Cl_5$

(v) $[Co(en)_3]Cl_3$

(b) What is the chelate effect? Chelate effect is predominantly due to entropy change. Explain.

(c) Which of the following have higher Δ_0 value and why?

(i) $[Fe(H_2O)_6]^{3+}$ or $[Fe(CN)_6]^{3-}$

(ii) $[Cr(NH_3)_6]^{2+}$ or $[Cr(NH_3)_4]^{2+}$ (5,5,5)

P.T.O.

3. (a) Write the formulae of the following complexes according to the IUPAC system of nomenclature :

(i) pentaamminenitrito-O cobalt(III) sulphate

(ii) potassium amminedicyanidodioxidoperoxido-chromate(VI)

(iii) μ-amido - μ-hydroxido bis[tetraammine-cobalt(III)]

(iv) tetrapyridineplatinum(II) tetrachlorido-platinate(II)

(v) Potassium tetrafluridoargentate(I)

(b) Define the terms transition state and intermediate state using reaction pathways.

(c) What is the effect of π acceptor ligand and π donor ligands on Δ_0? Explain on the basis of ligand field theory. (5,5,5)

4. (a) Explain why square planar complexes of Pt(II) often undergo associative substitution mechanisms, while octahedral complexes of Cr(III) typically undergo dissociative mechanisms.

(b) Draw and explain Crystal Field Splitting diagram for octahedral complexes.

(c) How will you distinguish between the following pairs of isomers?

(i) cis and trans $[Pt(NH_3)Cl_2]$

(ii) $[Co(NH_3)_5SO_4]$ I and $[Co(NH_3)_5I]$ SO_4

(5,5,5)

5. (a) Predict and sketch all the possible isomers of $[Cr(gly)_3]$.

[This question paper contains 8 printed pages]

Your Roll No.	:	.....
Sl. No. of Q. Paper	:	**5665 I**
Unique Paper Code	:	2172012403
Name of the Paper	:	DSC : Electrochemical Cells, Chemical Kinetics and Catalysis
Name of the Course	:	**B. Sc. (Hons.) Chemistry**
Semester	:	IV

Time : 3 Hours ***Maximum Marks : 90***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt **(SIX)** Questions in all. **First** question is Compulsory.

(c) Use of a Scientific calculator is permitted.

(d) Graph paper will be provided.

1. Attempt any **Five** parts.

(a) What is liquid junction potential ? Why is NH_4NO_3 salt a good choice for making a salt bridge ?

(b) Construct the cell in term of cell notation using the following cell reaction :

$Fe(OH)_3(s) \rightarrow Fe^{3+}(aq) + 3OH^-(aq)$

(c) The standard redox potential of the water oxidation to dioxygen is -1.23 V.

$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$. Calculate the redox potential of the same reaction at pH = 7

(d) The acid hydrolysis of the same quantity of ester is done separately with equal normal solutions of HCl & H_2SO_4, it is given that $\frac{[H^+]_{HCl}}{[H^+]_{H_2SO_4}} = \frac{k_{HCl}}{k_{H_2SO_4}}$, explain whether the value of $k_{HCL}/k_{H_2SO_4}$ is less than, equal or greater than one.

(e) What are stationary and non-stationary chain reactions ? Discuss briefly.

(f) Ionic reactions are fast while molecular reactions are slow. Why ?

(g) Discuss, using potential energy barrier graph, the effect of catalyst on rates of the reaction.

5×3=15

2. (a) Given that :

$Fe^{3+}(aq) + 3e^- \rightarrow Fe(s)$; $E_1^0 = -0.04$ V

$Fe^{2+}(au) + 2e^- \rightarrow Fe(s)$; $E_2^0 = -0.44$V

Determine the potential of the following half-cell reaction.

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$

(b) What is the basic principle of potentiometric titration ? How is it applied to acid – base titration ?

(c) The standard potential of a cell "$Pt|H_2(g).|HBr(aq)|Ag$" was found to vary as $E^0(volt) = 0.01 - 1 \times 10^{-4}(T - 298) - 2 \times 10^{-6}(T - 298)^2$. Calculate the standard reaction entropy, ΔS^0 and enthalpy, ΔH^0 at 25°C.

3×5=15

3. (a) Given that the standard potential of the following half – cell reaction at 25°CK

$Cu^+(aq) + e^- \rightarrow Cu(s)$; $E_1^0 = 0.52V$

$Cu^{2+}(aq) + e^- \rightarrow Cu^+(aq)$; $E_2^0 = 0.16V$

Calculate ΔG^0 (in kJ) for the following reaction :

$2Cu^+(aq) \rightarrow Cu(s) + Cu^{2+}$

(b) A platinum electrode is immersed in a solution containing 0.1 M Fe^{2+} and 0.1 M Fe^{3+}. Its potential is found to be 0.77 V against SHE. Under standard conditions, the activity coefficient is unity. What is the potential of the electrode when the concentration of Fe^{3+} is increased to 1 M at 25°C.

(c) The cell constructed by the half cells.

$$E^0_{(Cd^{2+}|Cd)} = -0.403V \ \& \ E^0_{(I^-|AgI|Ag)} = -0.152V$$

has the potential of 0.29V at 25°C. Determine the activity of CdI_2 solution.

3×5=15

4. (a) Determine the formation of the complex, $Zn(NH_3)_4^{2+}$, Provided that

$$(a)\ Zn(s) + 4NH_3 \rightarrow Zn(NH_3)_4^{2+} + 2e^-;\ E^0 = 1.03V$$
$$(b)\ Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-;\qquad E^0 = 0.76V$$

(b) How do we use quinhydrone electrode for determination of pH of a given solution ? What are advantages and disadvantages of quinhydrone electrode ?

(c) Construct a concentration cell without transference using silver – silver chloride electrode and derive the equation for determination of cell potential of the concentration cell. 3×5=15

5. (a) The reaction

$$\nu_1 A + \nu_2 B \rightarrow \text{Products}$$

is a first order reaction with respect to A & B. Write down its differential rate law & deduce from it the Integrated rate law. What is the unit of rate constant in this case ?

(b) Suppose that in a consecutive reaction $A \xrightarrow{k_1} B \xrightarrow{k_1'} C, k_1' >> k_1$ prove that reaction with the smaller rate constant is the rate determining step. Given :

$$[C] = [A]_0 \left\{ 1 - \frac{1}{k_1' - k_1} \left(k_1' e^{-k_1 t} - k_1 e^{-k_1' t} \right) \right\}$$

(c) Write a short note on Lindemann Mechanism. 3×5=15

6. (a) Compare the rate constants as given by Arrhenius equation & the collision theory and there by show that

$$E_\alpha = E_0 + \frac{RT}{2} \quad \& \quad A = pN_A \frac{Z_{AB}}{N_A^* N_B^*} e^{1/2}$$

(b) Using the following data, obtain the differential rate expression for the following reaction & the value of rate constant

$CO + Cl_2 \rightarrow COCl_2$

Experiment No.	1	2	3	4
$[CoCl_2]_0$ / mol dm^{-3}	0.16	0.16	0.04	0.04
$[Cl_2]_0$ / mol dm^{-3}	0.16	0.04	0.16	0.04
r_0 / mol dm^{-3} s^{-1}	1.92×10^{-2}	9.6×10^{-3}	4.8×10^{-3}	2.4×10^{-3}

(c) Discuss the conditions under which the equilibrium approximation & steady state approximation is used while elucidating the mechanisms of the complex reactions. Support your answer with any general reaction in each case 3×5=15

7. (a) The following mechanism has been proposed for the decomposition of N_2O_5:

(i) $N_2O_5 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} NO_2 + NO_3$

(ii) $NO_3 + NO_2 \xrightarrow{k_2} NO + NO_2 + O_2$

(iii) $NO_3 + NO \xrightarrow{k_3} 2\,NO_2$

Show that rate law is $\frac{d[O_2]}{dt} = k[N_2O_5]$

(b) The bimolecular decomposition of Hydrogen Iodide is given by the equation

$2HI \rightarrow H_2 + I_2$

Assuming a collision diameter of 0.35×10^{-8} cm and an activation energy of 183.90 kJ mol^{-1} for the reaction, calculate (i) the collision rate, (ii) the rate of reaction and (iii) the rate constant for the above reaction at 500 K and one atmosphere pressure.

(c) Write a short note on Theory of Absolute Reaction rates. 3×5=15

8. (a) An acid, HA catalyses the substrate, S to products as follows :

$$S + H \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} SH^+ + A^{-1}$$

$$SH^+ + H_2O \xrightarrow{k_2} P + H_3O^+$$

Derive the rate law for the reaction. State when it becomes an example of "general acid catalysis" and it is *"specific hydrogen ion catalysis"*.

(b) Describe any five characteristics of catalyst.

(c) The reaction rate of enzyme – catalysed reaction changes from first – order to zero – order as the substrate concentration is increased. Discuss the reason on the basis of active sites & Explain using the graph of rate versus substrate concentration.

3×5-=15

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[This question paper contains 7 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **5697** **I**

Unique Paper Code : 2173012011

Name of the Paper : DSE: Reactions, Reagents and chemical Process

Name of the Course : **B.Sc.(Hons.) Chemistry**

Semester : IV

Time : 3 Hours ***Maximum Marks : 90***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt any **six** questions. **All** parts of a question should be attempted together.

(c) Each question carries **15** marks.

1. Explain any **three** of the following reactions with suitable mechanisms :

(a) Appel Reaction

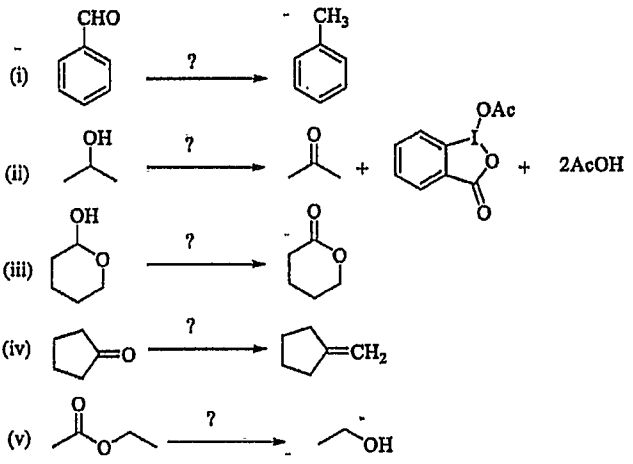
(b) Prevost Reaction

(c) Wittig Reaction

(d) Corey Kim OXidation 5,5,5

P.T.O.

2. (a) Identify the most suitable reagents required to accomplish the following chemical transformation:



(b) Write the chemical structure and mention one application of the following reagent:

(i) ABNO

(ii) DIBAL-H

(iii) DEMS

(iv) 3-Mercaptopropionic acid

(v) Fetizon's reagent 5,10

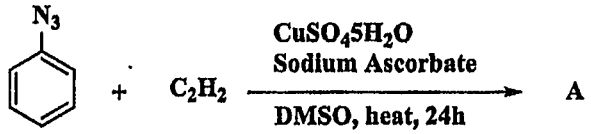
3. (a) What is the synthetic utility of Sodium borohydride and PMHS in organic synthesis? Explain with suitable example.

(b) Write the structure and synthetic application of following reagents:

(i) Fenton's Reagent

(ii) TRAP 10,5

4. (a) Identify and write the product (A) of the given Name Reaction. Mention the name of the reaction and provide a detailed mechanism to support your answer.



(b) Which reagent/catalyst is used in the following reactions?

(i) Darken West Reaction

(ii) Mitsunobu Reaction

(iii) Barbier Reaction

(iv) Damjanov Reaction

(v) maukaiyama Aldol Reaction

(c) Explain the Birch Reduction of aromatic Compounds with a suitable mechanism.

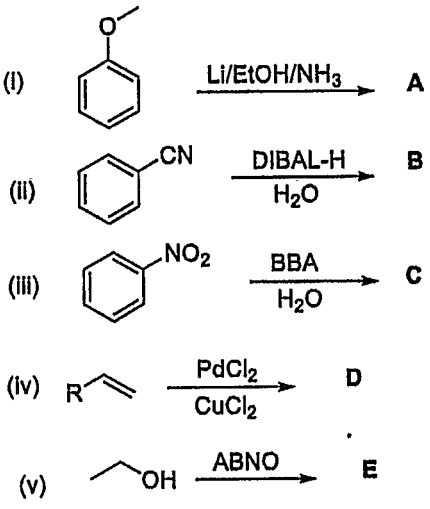
5,5,5

5. (a) Explain the various stages involved in the scale-up process of chemical reactions, highlighting the roles of bench, pilot, and large-scale processes.

(b) define nitration as a unit process, Describe the mechanism and name one process equipment used for technical nitration.

(c) What are catalytic halogenations? Differentiate between types of halogenations with suitable examples. 5,5,5

6. (a) Complete the following reactions by giving the product.



(b) Write the reaction and mechanism of Julia Olefination Reaction.

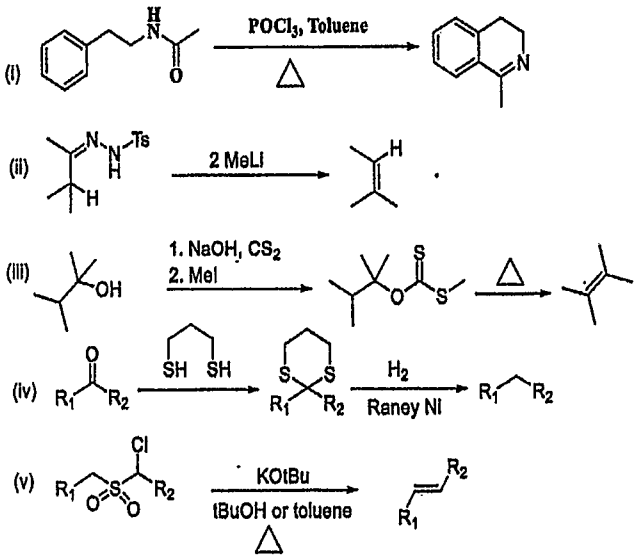
(c) Discuss the structure and oxidizing property of AZADO reagent. 5,5,5

7. (a) What a Suzuki coupling Reaction? Write the steps involved in the mechanism.

(b) Describe the Heck Reaction and show how it works step by step.

(c) Write the name of the following reactions:

5,5,5



8. (a) What is Schwartz's reagent? Describe its structure and specific application in organic chemistry.

(b) Write the mechanism of Swern oxidation and discuss its advantages over other oxidation methods.

(c) Explain the use of sodium bismuthate and sodium perborate in organic oxidations.

5,5,5

(b) Explain SN2 reaction with mechanism and stereochemistry involved.

(c) What do you understand by Geometrical isomerism. Explain E/Z isomerism and draw the E/Z isomers of 1,2-dichloroethene. (5,5,5)

5. (a) Classify the following as electrophiles or nucleophiles. Justify your answer for SO_3, $:CCl_2$, BF_3, NH_3, H_2O.

(b) Show E1 and E2 mechanism with example. Differentiate between Hoffmann and Cope Elimination reaction.

(c) Explain why nitrobenzene directs the incoming electrophile to meta position. Draw the resonating structure to justify the answer. (5,5,5)

6. Write short notes on the following : (Any **Three**)

(i) Stability, Shape and hybridization of Free radical

(ii) Friedel Craft Alkylation

(iii) Ozonolysis of alkenes and alkynes

(iv) Nitration of benzene with mechanism. (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5045 **J**

Unique Paper Code : 2174001002

Name of the Paper : GE Basic Concepts of Organic Chemistry

Name of the Course : **All Undergraduate Courses Except with Chemistry Discipline**

Semester : II / IV / VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Answer **four** questions in all.
3. Each question carries **15** marks.

1. Account for the following statements **(Any Five)**

   (a) Explain why Benzylamine is more basic than aniline

   (b) How does the solvent system effect the SN1 and SN2 mode of reaction?

   (c) Why addition of bromine to propene is anti-addition? Explain giving mechanism.

   (d) Write short notes on aromaticity and role of Huckle rule in aromaticity.

   (e) Clarify Racemic Mixture is optically inactive with example

   (f) What is electromeric effect? Explain with the help of suitable reaction. (3,3,3,3,3)

2. (a) Comment and discuss that 2,2,2-trifluoroethanol is much more acidic than ethanol with respect to dipole moment.

   (b) Explain Inductive effect and resonance effect. (Give at least four points of difference).

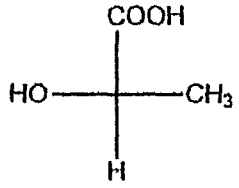
   (c) What is hyperconjugation effect? Explain the order of stability of primary, Secondary and tertiary carbocations on the basis of this effect.

   (5,5,5)

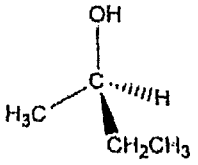
3. (a) Draw all the possible stereoisomers of 2,3-Dibromopentane in Fischer Projection. Comment on their optical activity and give the relationship between them. Designate erthyro and threo nomenclature to each stereoisomer.

   (b) Define chirality. How do you identify a chiral carbon in a compound? Explain with an example of 2-butanol.

   (c) Assign R/S to the following compounds (any **two**) and convert Fisher projection to Newman or vice versa.



(i)



(ii)

(5,5,5)

4. (a) How will you identify Markownikoff and anti-markownikoff addition in alkenes addition reaction. Explain with any suitable example in electrophilic addition of alkene.

(c) Describe the mechanism of acid catalysed reaction in which acid form of substrate reacts with water. Discuss the cases : (i) $k_2 >> k_{-1}[A]$ and (ii) $k_2 << k_{-1}[A]$. (5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5854 **J**

Unique Paper Code : 2172523601

Name of the Paper : DSE – Conductance, Electrochemistry and Chemical Kinetics

Name of the Course : **B.Sc. Life Science**

Semester : VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **four** questions in all, question No. **1** is compulsory.
3. The answers should be numbered in accordance to the number in the question paper.
4. Use of Scientific Calculator is permitted.

($R = 8.314\ J\ K^{-1}\ mol^{-1}$ $k = 1.38\times10^{-23}\ J\ K^{-1}$ $N_A = 6.023\times10^{23}$)

1. Answer any **Five** (3×5)

(a) Differentiate between order and molecularity of a reaction giving examples.

(b) The molar conductance of an electrolyte solution increases, whereas its specific conductance decreases with dilution. Explain.

(c) Why it is not possible to determine the equivalent conductance of a weak electrolyte at infinite dilution by direct measurement using conductivity meter?

(d) A finely powdered substance is more effective catalyst. Why?

(c) In a particular reaction the time required to complete half of the reaction was found to increase 16 times when the initial concentration of the reactant was reduced to one fourth. Determine the order of the reaction? (5)

6. (a) The kinetics of enzyme catalysed reaction is studied by Michaelis-Menton mechanism. Using the suitable approximation, relate enzyme and substrate concentration to the rate of the reaction. Also discuss how the rate of reaction varies when Michaelis-Menton constant is greater than enzyme concentration. (5)

(b) Describe characteristics of a catalyst. (5)

(b) Explain the concept of activation energy of reaction. Derive expression for its calculation from Arrhenius equation. (5)

(c) The rate constant for a second order reaction is 5.7×10^{-5} dm^3 mol^{-1} s^{-1} at 25°C and 1.64×10^{-4} dm^3 mol^{-1} s^{-1} at 40°C. Calculate the activation energy of the reaction. (5)

5. (a) Derive expression between EMF and equilibrium constant of reversible cell. (5)

(b) Using integrated rate expressions, derive equations for half-life of first and second order reactions. (5)

(e) Why a first order reaction never reaches completion?

(f) Draw labelled energy profile diagrams for endothermic and exothermic reaction using a catalyst.

2. (a) State Kohlrausch's law of independent migration of ions. How does it help in determination of equivalent conductance at infinite dilution of weak electrolytes? (5)

(b) If the molar conductance at infinite dilution of NaCl, HCl and CH_3COONa are 126, 420, and 91 S cm^2 mol^{-1} respectively, calculate molar conductance of acetic acid at infinite dilution.

(5)

(c) Calculate the transference numbers of H^+ and Cl^- ions from the following data obtained from the moving boundary method using cadmium chloride as indicator electrolyte, Given:

Atomic mass of Ag = 108 g mol^{-1}

Concentration of HCl solution = 0.1 N

Mass of Ag deposited in the coulometer = 0.1209 g

Movement of boundary = 8.5 cm

Cross-section of the tube = 1.1 cm^2. (5)

3. (a) What is meant by transference number? Describe the Hittorfs method to determine experimentally the transference number of ions. (5)

(b) For the electrochemical cell :

$Cd \mid CdCl_2.5/2H_2O$ (aq) $\parallel$ AgCl(s) $\mid$ Ag

the EMF at 0°C and 25°C are 0.6915 V and 0.6753 V, respectively.

The cell reaction is: $Cd(s) + 2AgCl(s) + H_2O \rightarrow CdCl_2.5/2H_2O$ (sat.) + 2Ag(s)

Calculate $\Delta G°$, $\Delta H°$ and $\Delta S°$ at 25°C. (5)

(c) Discuss the titration curves obtained from conductometric titrations of

(i) HCl vs. NaOH solution

(ii) Formic acid vs. NaOH solution (5)

4. (a) State the principle underlying the potentiometric titrations. What are the advantages of potentiometric titrations over volumetric titrations? Explain the potentiometric titration curve involving an acid and a base. (5)

(c) How will you differentiate between the terminal CO and bridging CO?

(d) Complexes with chelating ligands are more stable than the complexes with non-chelating ligands. Explain, with a suitable example. (5,4,3,3)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4653 **J**

Unique Paper Code : 2174001203

Name of the Paper : GE: Coordination and Organometallic Compounds

Name of the Course : **All Undergraduate Courses Except with Chemistry**

Semester : II / IV / VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions.
3. **All** questions carry equal marks.

1. (a) For Mn^{3+} ion, mean pairing energy P is found to be 28000 cm^{-1}, Δ_o values for the complex $[Mn\ (H_2O)_6]^{3+}$ and $[Mn\ (CN)_6]^{3-}$ are 21000 and 38500 cm^{-1} respectively. Do these complexes have low spin or high spin configuration? Also write down the configuration corresponding to these states.

(b) What is meant by synergic effect? How does it account for the formation of carbonyl complexes of transition metals in low oxidation states.

(c) Ni (II) is stabilized in the formation of square planar rather than octahedral geometry in the presence of strong field ligands. Explain why?

(d) Predict whether the following obey EAN rule and explain

H Mn $(CO)_5$, $[Co\ (CO)_3(\eta^3\text{-}C_3H_5)]$, $Rh_2(CO)_4Cl_2$

(5,4,3,3)

2. (a) Discuss how does CO behave as σ donor and π acceptor, through carbon atom in metal carbonyls, with reference to MO diagram.

(d) Define Jahn-Teller theorem. Giving reasons, explain in which case this effect would be observed?

$t_{2g}^3 e_g^1$ or $t_{2g}^6 e_g^2$ (5,4,3,3)

6. (a) How will you rationalise the increase in C-C bond length from 133.7 pm in ethene to 137.5 pm in Ziese's salt, accompanied by a decrease in C-C stretching frequency from 1623 cm-1 to 1526 cm–1?

(b) Give the IUPAC names of the following complexes **(any four)** :

(i) $K_4[Fe\ (CN)_6]$

(ii) $[Cr\ (ONO)(NH_3)_2Br_2H_2O]$

(iii) $[Co\ (NH_3)_5Cl]\ Cl_2$

(iv) $Na_2[ZnCl_4]$

(v) $K_2\ [OsNCl_5]$

(ii) $[Rh(NH_3)_6]^{3+}$ and $[Co(NH_3)_6]^{3+}$

(5,4,3,3)

5. (a) Write chemical formulae for the following compounds :

(i) Ammonium tris(oxalato)cobaltate (III)

(ii) Potassium oxidotetrafluoridochromate (V)

(iii) Dichlorido bis(triphenylphosphine) nickel (II)

(iv) Tetrachlorido 1,2-diaminoethane platinum (IV)

(v) Hexaammine cobalt (III) hexacyanidochromate (III)

(b) Draw the structures for the following :

$Fe_2(CO)_9$, $Re_2(CO)_{10}$, $Fe(CO)_5$, $Co_2(CO)_8$

(c) Which of the following are not organometallic compounds and why?

$[K_2Zn(CN)_4]$, $(C_2H_5)_4Pb$, Me_4Sn, $B(OCH_3)_3$

(b) Draw the orbital splitting diagram for tetrahedral $[CoCl_4]^{2-}$ and give its electronic configuration. Calculate its CFSE.

(c) What are homoleptic carbonyls? Give two examples.

(d) The magnetic moment for $[MnBr_4]^{2-}$ and $[Mn(CN)_6]^{3-}$ are 5.9 and 2.8 BM respectively. Give the hybridisation, geometry of each complex on the basis of VBT. (5,4,3,3)

3. (a) On the basis of VBT answer the following questions for the six coordinated complex ion: $[Fe(CN)_6]^{3-}$

(i) What is the oxidation state of Fe?

(ii) What type of hybridization is involved?

(iii) State whether the given complex is inner or outer orbital complex.

P.T.O.

(iv) What is the magnetic behaviour of the complex ion?

(v) Calculate the value of magnetic moment.

(b) CO_2CO_8 (s) shows IR stretching frequencies at two different regions, 2100-2000 cm^{-1} and 1850-1880 cm^{-1}. However, in $Mn_2(CO)_{10}$ all CO stretching frequencies are observed in one region at 2100 cm^{-1}. Predict their structure based on the results of IR data.

(c) Explain the increasing Δ_o values observed in case of the following :

Complex	Δ_o (cm^{-1})
$[Co(NH_3)_6]^{3+}$	23000
$[Rh(NH_3)_6]^{3+}$	34000
$[Ir(NH_3)_6]^{3+}$	41000

(d) What are π-acid ligands? Illustrate with one suitable example. (5,4,3,3)

4. (a) Discuss the structure of the following :

(i) Methyl Lithium

(ii) Ferrocene in solid and gaseous phase

(b) The complex ion $[Ni(H_2O)_6]^{2+}$ is a regular octahedral but $[Cu(H_2O)_6]^{2+}$ is distorted octahedral. Explain why.

(c) Using the 18 electron rule as a guide, identify/ find

(i) The 3d metal in $[\eta^5\text{-}C_5H_5)\ M\ (C_2H_4)_2]$

(ii) The probable number of carbonyl ligands in $[W(\eta^6\text{-}C_6H_6)\ (CO)_n]$.

(iii) The number of Ru-Ru bonds in $[Ru_3(CO)_{12}]$

(d) Which complex in each of the following pairs will have greater crystal field splitting and why

(i) $[Fe(C_2O_4)_3]^{4-}$ and $[Fe(C_2O_4)_3]^{3-}$

2618

Unique Paper Code :	42177926
Name of the Paper :	DSE: Organometallics, Bio-inorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy
Name of the Course :	B.Sc. (Programme)
Semester :	VI
Duration :	3 hours
Maximum Marks :	75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Use separate sheets for **Section A** and **Section B**.
3. Attempt **three** questions from each section.
4. Do not intermix the sections and attempt all parts of a question paper together.
5. All questions carries equal marks.

Section A

Attempt any **three** questions

1. (a) Write down the balanced chemical equation for the following reactions:
   (i) $K_2Cr_2O_7$ is treated with H_2O_2 in acidic medium in the presence of ether.
   (ii) $K_4[Fe(CN)_6]$ is boiled with dilute H_2SO_4.
   (iii) NaCl is heated with $K_2Cr_2O_7$ and conc. H_2SO_4.
   (iv) $KMnO_4$ in acidic medium is reacted with potassium iodide.
   (b) Give structure, oxidation state of metal and hybridization for the following:
   (i) $K_4[Fe(CN)_6]$
   (ii) $KMnO_4$
   (c) When MnO_2 is fused with KOH in the presence of air, a fused mass containing a green coloured compound (A) is obtained, which is extracted with water. (A) on treatment with any oxidising agent gives a compound (B). Compound (B) when treated with conc. H_2SO_4 gives compound (C) which is explosive in nature. Identify A, B, and C along with the chemical equations involved.

   (4,4,4.5)

2. (a) Arrange the following species in increasing order of the property mentioned;
   (i) IR stretching frequency of C – O bond:
   $[Cr(CO)_6]$, $[V(CO)_6]^-$, $[Fe(CO)_4]^{2-}$
   (ii) Bond length of M – C bond:
   $[Ni(CO)_4]$, $[Mn(CO)_6]^+$, $[Ti(CO)_6]^{2-}$
   (b) Predict which of the following will be stable using 18 e^- rule:
   (i) $[Fe(CO)_4]^{2+}$ (ii) $[(\eta^3\text{-}C_5H_5)(\eta^5\text{-}C_5H_5)Fe(CO)$ (iii) $[HMn(CO)_5]$ (iv) $[Co(CO)_4]$

(c) Discuss the donor as well as acceptor character of CO through carbon atom in metal carbonyls with reference to MO diagram.

(4, 4, 4.5)

3. (a) Name the metal which is present in chlorophyll. Discuss its role in energy production in chlorophyll.
   (b) Draw and explain the nature of oxygen dissociation curve for Hemoglobin and Myoglobin.
   (c) What is the difference between active and passive transport? Discuss the working of the sodium-potassium pump giving a diagrammatic representation of the process and the mechanism involved in it.

(4, 4, 4.5)

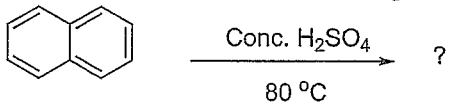
4. (a) What is meant by the term Hapticity of the ligands? Give an example of ligands with hapticity 3, 5 and 6.
   (b) Draw and explain the structure of methyllithium. In which category of organometallic compounds will you place it?
   (c) Describe the Perutz mechanism of oxygenation of hemoglobin.

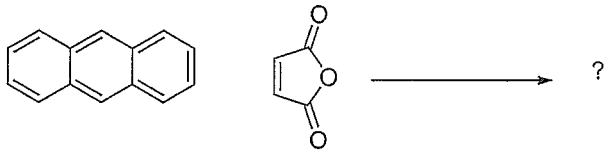
(4, 4, 4.5)

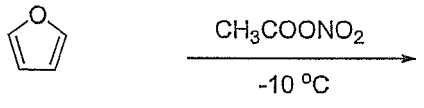
SECTION B

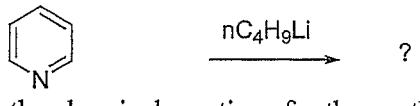
Attempt any **three** questions

5. (a) Write the products formed in the following chemical reactions:

(i) 

(ii) 

(iii) 

(iv) 

   (b) Write down the chemical reactions for the synthesis of the following compounds using ethyl acetoacetate.
      (i) Crotonic acid
      (ii) 2-pentanone
   (c) Explain the different types of bending vibrations in IR spectroscopy and why C-H stretching vibrations move to higher frequency in the sequence: alkane<alkene<alkyne.

(4, 4, 4.5)

6. (a) How the following pairs of the compounds can be distinguished using IR spectroscopy:

(i) CH_3CHO and C_6H_5CHO

(ii) $C_6H_5NHCOCH_3$ and p-CH_3-$C_6H_4CONH_2$

(b) How will you convert naphthalene into:

(i) 1-naphthylamine

(ii) 2-naphthol

(c) Give the reaction and mechanism for the synthesis of ethyl acetoacetate by Claisen ester condensation.

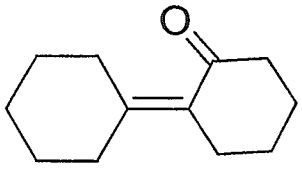
(4, 4, 4.5)

7. (a) Justify the following statements about furan:

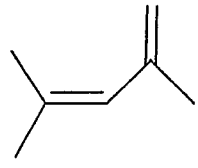
(i) Furan is the only five membered heterocyclic compound which undergoes Diels-Alder reaction.

(ii) Electrophilic substitution of furan cannot be carried in the presence of concentrated strong acids.

(b) Calculate the λ_{max} by using Woodward-Fieser Rules.



Base value=215 nm



Base value=217 nm

(c) Arrange various types of transitions induced in a molecule by absorption of UV radiation in increasing order of energy? Explain with examples.

(4, 4, 4.5)

8. (a) Write short note on **any two** of the following:

(i) Fingerprint region in IR.

(ii) Bathochromic and Hypsochromic shift

(iii) Lambert's Beer Law

(b) Explain the following:

(i) Why naphthalene can be nitrated by nitric acid in acetic anhydride, but benzene requires fuming nitric acid and concentrated sulphuric acid?

(ii) Why Pyrrole requires much milder nitration reaction conditions (HNO_3 + Acetic anhydride) than that are used in case of pyridine (HNO_3/H_2SO_4 at 300°C).

(c) Explain the structure elucidation of Naphthalene. Write down all the steps involved with chemical reactions.

(4, 4, 4.5)

(c) Predict and draw the intensity distribution in hyper fine lines of ESR spectrum of methyl radical ($^{\bullet}CH_3$). (5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5566 **J**

Unique Paper Code : 2172013603

Name of the Paper : DSC-PHOTOCHEMISTRY AND SPECTROSCOPY

Name of the Course : **B.Sc. (Hons) Chemistry**

Semester : VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **FOUR** questions in all. Question No. **1** is compulsory.
3. The questions should be numbered in accordance to the number in the question paper.
4. Use of Scientific Calculator is permitted.

Planck's Constant: 6.626×10^{-34} Js : Mass of Electron: 9.1×10^{-31} Kg

1. Answer **any 5** of the following :

(a) Zero-point energy in vibrational spectra is never zero. Comment.

(b) Why electronic transitions are said to be vertical transitions.

(c) Why the symmetric stretching mode of vibration of CO_2 molecule is Raman active and asymmetric mode of vibration is Raman inactive?

(d) What are the laws of photochemistry?

(e) Explain the terms chromophore and auxochrome. Give one example of each.

(f) As the number of conjugated atoms in a molecule increases, red shift is observed. Explain with help of one example. (5×3=15)

(b) Explain the Phosphorescence phenomenon with the help of a suitable energy diagram. Why is it a delayed phenomenon?

(c) The first UV peak of 1,3-butadiene is observed at 210 nm, corresponding to a transition from HOMO (highest occupied molecular orbital) to LUMO (lowest unoccupied molecular orbital). Based on free electron model, calculate the length of the box to which this transition corresponds.

(5,5,5)

6. (a) Explain the term chemical shift. What is TMS? Why is it used as a reference standard in NMR?

(b) What is spin-spin coupling? Explain and sketch the NMR spectrum of methanol with and without spin-spin coupling.

(ii) Triple bond has higher stretching frequency than corresponding double bond, which in turn has higher frequency than single bond. Explain.

(c) A molecule XY_2 has the following IR and vibrational Raman spectral data :

Wavenumber (cm^{-1})	IR	Raman
1243	Inactive	Active
2920	Active (PR)	Inactive
786	Active (PQR)	Inactive

Predict the geometry of XY_2 molecule. (5,5,5)

5. (a) Define Lambert-Beer's Law. What are its limitations? Give one application of this law.

2. (a) What is the essential condition for a molecule to be microwave active? Which of the following molecules are expected to be microwave active: SF_6, H_2O, N_2, HCN, NO, and CO_2. Give reason.

(b) The HCl molecule shows pure rotational lines at the following frequencies (cm^{-1})

20.7, 41.4, 62.1, 82.8

Assign these lines to the corresponding $J \rightarrow J+1$ rotational transitions. Calculate the bond distance of HCl.

The atomic masses are : H = 1.673×10^{-27} kg; Cl = 58.06×10^{-27} kg.

(c) (i) Explain, why many of the lower rotational levels are thickly populated.

(ii) Show that the rotational level whose quantum number is given by the expression has a maximum population :

$$J = \sqrt{\frac{kT}{2Bhc}} - \frac{1}{2}$$ (5,5,5)

3. (a) Discuss how a simple harmonic oscillator system differs from a homonuclear diatomic molecule undergoing anharmonic oscillations in terms of energy relation and energy vs displacement curve from mean position.

(b) (i) How the presence of Hydrogen bonding can be predicted in IR spectra? Explain with an example.

(ii) An intense band and the first overtone transition of HBr (bond length 0.142 nm) are centered at 2560 cm^{-1} and 5028 cm^{-1}.

Calculate the anharmonicity constant and force constant for H-Br bond. Mass of hydrogen: 1.0 g/mol and Mass of Br: 80.0 g/mol.

(c) (i) How will you distinguish between the overtones and hot bands of a spectrum?

(ii) Calculate the number of fundamental vibrational modes for NH_3, H_2O and HCN.

(5,5,5)

4. (a) What are Rayleigh, Stokes and anti-Stokes lines? How is the intensity of stokes lines different from that of anti-stokes lines in pure Raman spectrum? Explain giving reasons.

(b) (i) Explain the factors that control intensity of spectral lines/band.

(b) Differentiate between 1-butene and 1-butyne using IR spectroscopy.

(c) Explain, why [2+2] cycloaddition reaction are photochemically allowed and thermally forbidden. (5,5,5)

8. Write short notes on **(Any three)** :

(a) Haworth synthesis of naphthalene

(b) Norrish Type II reaction

(c) Witt's theory of colour

(d) Claisen rearrangement (5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5546 **J**

Unique Paper Code : 2172013602

Name of the Paper : DSC : Polynuclear Hydrocarbons, Photochemistry, Pericyclic reactions, and Spectroscopy of Organic Compounds

Name of the Course : **B.Sc. (H) Chemistry**

Semester : VI

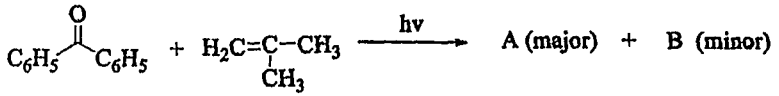
Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **six** questions. **All** parts of a question should be attempted together.
3. Each question carries **15** marks.

P.T.O.

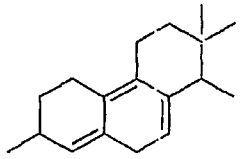
1. (a) Complete the following reaction

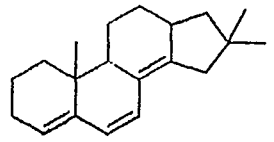


(i) Write the name of the reaction.

(ii) Explain the formation of products.

(b) Calculate the λ_{max} value for the following compounds

i) 

ii) 

Base value for homo annular diene = 253 nm, Base value for heteroannular diene = 215 nm; Alkyl group or Ring residue = 5 nm, Exocyclic double bond = 5 nm, Double bond extended conjugation = 30 nm

(c) Acetylenic protons are more shielded as compared to ethylenic protons. Explain. (5,5,5)

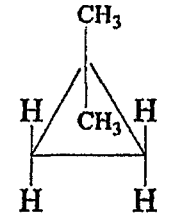
2. (a) An organic compound with molecular formula $C_6H_{12}O$ showed the following spectral data:

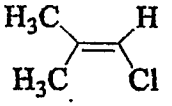
(c) In an organic compound, three kinds of protons appear at 60,100 and 180 Hz when the spectra are recorded at 60 MHz spectrometer.

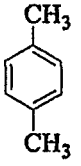
(i) Determine the chemical shift.

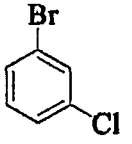
(ii) Relative position (in Hz) when 90 MHz spectrometer is used. (5,5,5)

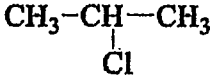
7. (a) Give the number of PMR signal in each of the following :

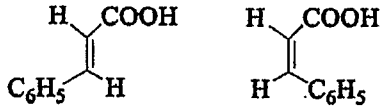
(i) 

(ii) 

(iii) 

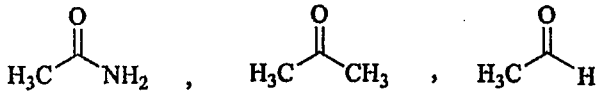
(iv) 

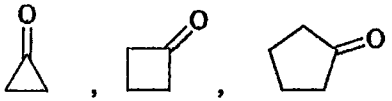
(v) 



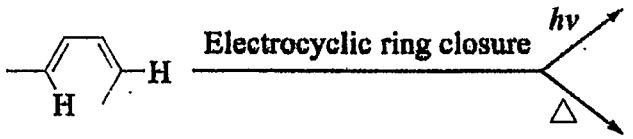
(c) Draw the PMR of pure and impure ethanol. Give reasons for the difference.

6. (a) Arrange the following compounds in order of increasing order of carbonyl absorption frequency in IR spectroscopy. Give reasons.

(i) 

(ii) 

(b) Complete the following reaction and explain the formation of products



(2E,4Z) 2,4-Hexadiene

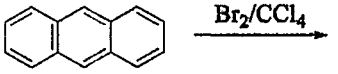
UV: λ_{max} = 288 nm, ε = 24; IR: A very strong band at 1715 cm^{-1}; ^{1}HNMR: δ values 2.0 (3H, s) and 1.0 (9H, s)

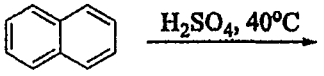
(i) Calculate the double bond equivalence

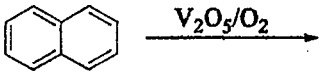
(ii) Deduce the structure of the compound

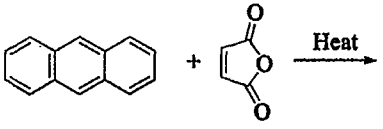
(iii) Explain (a) UV transition (b) IR absorption band (c) NMR peaks along with splitting patterns

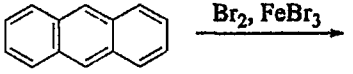
(b) Complete the following reactions :

(i) 

(ii) 

(iii) 

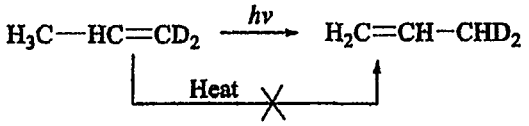
(iv) 

(v) 

P.T.O.

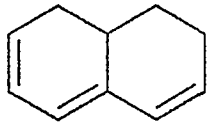
(c) Explain giving reason. Why IR spectrum of liquid *t*-butyl alcohol shows a strong absorption at 3360 cm^{-1}? Whereas a very dilute solution of the same compound in CCl_4 shows a strong absorption band at 3620 cm^{-1} instead of 3360 cm^{-1}. (5,5,5)

3. (a) Using the Frontier Molecular orbital approach, explain why [1,3] sigmatropic hydrogen shift is photochemically allowed and thermally forbidden.



(b) Write the full form and structure of TMS. Why it is used as internal reference?

(c) An organic compound (A) on partial hydrogenation with one equivalent of H_2 gives three isomers with molecular formula $C_{10}H_{14}$. Show how UV can distinguish these isomers.



Compound (A)

(5,5,5)

4. (a) How will you establish that in naphthalene two benzene rings are fused at *ortho* positions.

(b) Write the structural formula for the compounds with the following molecular formula that shows only one signal in their PMR spectra

(i) $C_3H_6Cl_2$ (ii) C_5H_{12}

(iii) C_4H_6 (iv) C_5H_{10}

(v) C_2H_6O

(b) A carbonyl compound shows the following data:

Solvent	λ_{max} (ε)	λ_{max} (ε)
Hexane	230 (12,600)	327 (98)
Water	245 (10,000)	305 (60)

Assign the various transitions. Explain the shift when the solvent is changed from hexane to water. (5,5,5)

5. (a) Explain, why electrophilic substitution in anthracene occurs at C-9 and C-10 position.

(b) Explain, which one is having higher λ_{max} (in UV spectroscopy) and higher value of $\nu_{c=o}$ (in IR spectroscopy)

P.T.O.

(b) Describe the cooperative effect in hemoglobin. Is this effect present in myoglobin? Explain.

(c) Inability to synthesize transferrin may result in anemia as well as an overload of iron. Do you agree? Justify your answer. (5,5,5)

5. (a) Name the reagent used to distinguish the II A group from the II B group in qualitative analysis. Explain its role. How will you identify copper in the presence of cadmium in qualitative analysis?

(b) Both group II and group IV cations precipitate out as their sulphides, but some cations are placed in group II and others in group IV. Explain.

(c) When both NO_3^- and Cl^- are present, sometimes no brown vapours are evolved. Explain. How will you confirm when these two ions are present together? (5,5,5)

6. (a) Discuss the health effects caused by the excess and deficiency of any two trace metals in the human body.

(b) How will you identify sulphite and carbonate ions when present together? Write down the chemical reactions involved in it.

(c) Why is it necessary to test Group V ions in the order: Ba^{2+}, Sr^{2+}, Ca^{2+}? (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5506 **J**

Unique Paper Code : 2172013601

Name of the Paper : DSC: Principles in Qualitative Analysis & Bioinorganic Chemistry

Name of the Course : **B.Sc. (H) Chemistry**

Semester : VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll. No. on the top immediately on receipt of this question paper.
2. Attempt **FOUR QUESTIONS** in all.
3. All Questions carry **equal** marks.

1. (a) Elements such as Silicon, Aluminium, and Titanium are abundant in the Earth's crust but play only a marginal role in biological systems. Explain why.

(b) How is the unequal concentration of Na^+ and K^+ ions in extracellular and intracellular fluids regulated in the human body? Provide a diagrammatic representation of the process and explain the mechanism involved.

(c) Explain the working mechanism of the calcium pump using ATP. What would happen if the calcium pump stops functioning in muscle cells? (5,5,5)

2. (a) A mixture of salts, when heated with ethanol and concentrated H_2SO_4, gives a gas (A), which burns with a green-edged flame when ignited. The mixture also gives a red gas (B) when heated with potassium dichromate and concentrated H_2SO_4. The pungent gas evolves on heating the mixture with NaOH solution, gives a brown precipitate (C) with potassium tetraiodomercurate (II). The residue left after boiling the mixture with dilute HCl is soluble in hot water. The hot solution gives a white precipitate (D) with dilute sulphuric acid and a yellow precipitate (E) with potassium chromate solution. Identify (A)-(E) and name the ions present.

(b) A test tube contains an aqueous solution of Fe^{3+}, Al^{3+}, and Cr^{3+}. Suggest the reagents used to

separate the three cations from each other. Discuss one confirmatory test of each cation with a chemical reaction.

(c) Identify the ion for which the following reagents are used. Write down the chemical reaction between the ion and the reagent.

(i) Sodium nitroprusside

(ii) Zirconyl nitrate

(iii) Ammonium thiocyanate

(iv) Sodium bismuthate (5,5,5)

3. (a) Explain the mechanism of action of carbonic anhydrase in converting carbon dioxide to bicarbonate. Draw a diagram of its active site.

(b) What are the toxic effects of lead? Give the reasons for its toxicity. How can it be treated?

(c) Draw and label the dose-response curves for an essential element and a toxic element. (5,5,5)

4. (a) How does cytochrome c oxidase contribute to ATP synthesis? Discuss its role in oxidative phosphorylation.

(c) The fundamental vibrational frequency of HCl is 2890 cm^{-1}. Calculate the force constant of this molecule. (5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5855 **J**

Unique Paper Code : 2172513601

Name of the Paper : DSC: QUANTUM CHEMISTRY AND SPECTROSCOPY

Name of the Course : **BACHELOR OF SCIENCE PHYSICAL SCIENCES WITH CHEMISTRY**

Semester : VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions.
3. Scientific calculator is permitted.

Physical Constants

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg

Velocity of light, $c = 3.0 \times 10^{8} ms^{-1}$

Planck's constant, $h = 6.626 \times 10^{-34} Js$

Atomic mass of $H^1 = 1.673 \times 10^{-27}$ kg

Atomic mass of $Cl^{35} = 58.06 \times 10^{-27}$ kg

Atomic mass of $C^{12} = 1.99 \times 10^{-26}$ kg

Atomic mass of $O^{16} = 2.66 \times 10^{-26}$ kg

1. (a) What are the postulates of quantum mechanics?

   (b) Derive Schrodinger wave equation.

   (c) Derive the expression for energy of a particle in one-dimensional box. (5,5,5)

   (i) C_2H_6

   (ii) C_2H_2

   (iii) C_2H_4

   (c) Briefly explain the fluorescence and phosphorescence using Jablonski diagram. (5,5,5)

6. (a) What is the difference between atomic and molecular spectra?

   (b) The inter molecular distance of carbon monoxide molecule is 1.13×10^{-10} m. Calculate the energy (in joules) of this molecule in the first exited rotational level.

(ii) H_2O

(iii) C_6H_6

(iv) $CHCl_3$

(v) O_2 (5,5,5)

5. (a) What is the effect of hydrogen bonding (inter- and intramolecular) on vibrational frequencies (IR frequencies) of molecules? Explain with suitable examples.

(b) What is the influence of Inductive effect on IR frequencies of organic molecules? Arrange the following molecule according to increasing order of its C-H stretching frequencies.

2. (a) What is the ground state energy for an electron which is confined to a potential well (one-dimensional box) having a width of 0.2 nm.?

(b) Calculate the transmittance, absorbance and absorption coefficient of a solution which absorbs 90% of a certain wavelength of light beam passed through a 1 cm cell containing 0.25 M solution.

(c) The pure rotational (microwave) spectrum of gaseous HCl consists of a series of equally spaced lines separated by 20.80 cm^{-1}. Calculate the intermolecular distance of the molecule.

(5,5,5)

3. Write short note on **any three** of the following :

(a) Chromophores and Auxochromes

(b) Bathochromic and Hypsochromic shifts

(c) Born- Oppenheimer approximation

(d) Lambert-Beer's law (5,5,5)

4. (a) Which of the following molecules will show a vibrational infrared spectrum and why?

(i) Cl_2

(ii) HCl

(iii) CH_3Cl

(iv) C_6H_6

(v) NH_3

(b) Which of the following molecules will show a pure rotational spectrum and why?

(i) H_2

(ii) HBr

(iii) C_2H_6

(iv) C_6H_6

(v) H_2O

(c) How many fundamental vibrational frequencies (i.e. fundamental vibrational degrees of freedom) are expected for the following molecules.

(i) CO_2

This question paper contains **3** printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **5621**

Unique Paper Code : **2173012019**

Name of the Paper : **DSE : Research Methodology for Chemists**

Name of the Course : **B.Sc. (Hons.) Chemistry**

Semester : **VI**

Duration : **3 Hours** Maximum Marks : **90**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *six* questions.

All questions carry equal marks.

1. (*a*) What is the purpose of literature review in the research process ? How can it help in conducting research ?

   (*b*) What is plagiarism ? Explain *one* technique to remove plagiarism.

   (*c*) What does the *h*-index indicate in research metrics ? How is it evaluated ? 5,5,5

2. (*a*) Differentiate between primary and secondary sources of information with examples.

   (*b*) What is TRIPS agreement ? Explain its general features and principles.

   (*c*) What are publication ethics ? Explain COPE in context with publication ethics. 5,5,5

P.T.O.

3. (*a*) Define e-Consortium and state its purpose giving examples. How does it differ from e-books ?

(*b*) Explain the statistical methods used for hypothesis testing : *t*-test, F-test, ANOVA.

(*c*) What does impact factor of a journal indicate ? Elucidate the steps involved in finding the impact factor of a journal. 5,5,5

4. (*a*) Name *one* journal published by each of the following publishing groups, in the field of Chemistry :

(*i*) ACS

(*ii*) Elsevier

(*iii*) RSC

(*iv*) Wiley

(*v*) Springer.

(*b*) Discuss different forms of Intellectual Property Rights. How are they useful ?

(*c*) State the methodology involved in data collection and its analysis. 5,5,5

5. Write short notes on any *three* of the following :

(*a*) ANOVA

(*b*) Google Scholar

(*c*) Orcid

(*d*) Chi-square test. 5,5,5

6. (*a*) What is Chem draw ? How does Chem draw help a chemist in research ?

(*b*) What is the median score achieved by a student who recorded the following scores on 10 tests ?

68, 55, 70, 62, 71, 58, 81, 82, 63, 73.

(*c*) Explain :

(*i*) Hypothesis

(*ii*) Formulating a research problem. 5,5,5

7. (*a*) What do you mean by CAS ? What is it use ?

(*b*) List out different steps of thesis writing and mention the software commonly used.

(*c*) Name and briefly explain the tools used for citation management. 5,5,5

8. (*a*) Find the standard deviation of the average temperatures recorded over a five-day period last winter : 18, 22, 19, 25, 12.

(*b*) Describe the key characteristics of a well-formulated hypothesis.

(*c*) Explain the key elements in designing a research/experiment. 5,5,5