[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5744 **K**

Unique Paper Code : 2172011101

Name of the Paper : DSC-1: Atomic Structure & Chemical Bonding (Inorganic Chemistry-I)

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

Semester : I

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. **All** questions carry equal marks.
3. Question No. **1** is compulsory.
4. The questions should be numbered in accordance with the number in the question paper.
5. Non-programmable calculators may be used.

1. Explain any **five** of the following giving reasons :

   (i) Ionic compounds are hard but brittle.

   (ii) NCl_5 does not exist whereas PCl_5 does.

   (iii) The first ionization enthalpy of Lithium is less than that of Ben Ilium but reverse is true for the second ionization enthalpy of Li.

   (iv) Half-filled and completely filled orbitals are more stable.

   (v) $CdCO_3$ decomposes at 350°C whereas $CaCO_3$ at 900°C.

   (vi) NaCl is soluble in water but insoluble in CCl_4. (5×3)

P.T.O.

2. (a) State the limitations of Bohr's Model of an atom. What are the different types of quantum numbers? Give their significance.

(b) Why is the atomic spectrum called the "fingerprint" of an element? In a hydrogen atom, an electron moves from the fifth to the second orbit. Calculate the wavelength of the corresponding spectral line. To which series of lines in the hydrogen spectrum does this spectral line belong, and in which region of the electromagnetic spectrum will it be observed?

(c) Explain the following :

(i) The electron gain enthalpy values of noble gases are taken to be zero.

(ii) The ionization energy of O is less than that of N. (5,5,5)

3. (a) Discuss the significance of Heisenberg's Uncertainty Principle for macro and microscopic particles. The uncertainty in position of a moving bullet of mass 0.02 kg is 5.0×10^{-6} m. Calculate the uncertainty in its velocity. ($h=6.626 \times 10^{-4}$ Js).

(b) Differentiate between the following :

(i) Atomic orbital and molecular orbital

(ii) Electron gain enthalpy and electronegativity

(c) What is an angular wave function? Discuss its significance. Specify the quantum number(s) on which angular wave function depends. How many angular nodes are present in a $3p_z$ orbital? (5,5,5)

4. (a) Explain the geometry and shape of the following molecules using VSEPR Theory :

(i) I_3^-

(ii) PCl_6^-

(b) What is s-p mixing in Molecular Orbital Theory? Draw the MO diagram of C_2 molecule and explain its magnetic property and bond order.

(c) What do you understand by radial probability? Draw the radial distribution function plots for the orbitals designated by the following quantum numbers:

(i) n=2, l=0

(ii) n=3, l=2

Indicate the number of radial nodes present in each case. (5,5,5)

5. (a) Define dipole moment. Calculate percentage ionic character in HCl molecule if its dipole moment and inter nuclear distance is 1.03 D and 127 pm, respectively. (ID = 3.336×10^{-30} Cm, charge on one electron = 1.6×10^{-19}C).

(b) What is Madelung's Constant? Explain, citing the example of NaCl. Write the Kapustinskii equation for lattice energy and give its advantages over Born-Lande equation.

(c) List the salient features of Valence Bond Theory and discuss its limitations. (5,5,5)

6. (a) Calculate the limiting radius ratio for octahedral geometry with coordination number 6. Discuss the limitations of radius ratio rules.

(c) Draw the Born-Haber Cycle for $NaCl_2$ and calculate its enthalpy of formation using following data:

Sublimation enthalpy of Na = 109 $kJmol^{-1}$

Dissociation enthalpy of Cl_2 = 243 $kJmol^{-1}$

First Ionization enthalpy of Na(g) to $Na^+(g)$ = 494 $kJmol^{-1}$

Second Ionization enthalpy of $Na^+(g)$ to $Na^{2+}(g)$ = 4561 $kJmol^{-1}$

Electron gain enthalpy of Cl(g) = –348.5 $kJmol^{-1}$

Lattice Energy of $NaCl_2$ = –2155 $kJmol^{-1}$

Is the formation of $NaCl_2$ feasible? Justify your answer.

P.T.O.

(d) Explain polarizing power and polarizability of an ion with examples. State the Fajan's rules. (5,5,5)

7. (a) Calculate the electronegativity of carbon from the following data: χ_H=2.1. E_{H-H} = 104.2 kcalmol^{-1}, E_{C-C} = 83.1 kcalmol^{-1} and E_{C-H} = 98.8 kcalmol^{-1}. How is electronegativity affected by hybridization? Arrange the following in order of increasing acidic character and justify: methane, ethylene and acetylene.

(b) CH_4, NH_3 and H_2O have tetrahedral geometry, yet their bond angles and dipole moments are different. Explain.

(c) What are isoelectronic ions? Arrange the following ions in increasing order of their sizes: N^{3-}, F^-, O^{2-}, Mg^{2+}, Na^+ & Al^{3+}. Justify your answer. (5,5,5)

8. (a) What do you understand by effective nuclear charge? Calculate the effective nuclear charge at the periphery of Chromium atom (Z=24). Discuss the limitations of Slater's rule.

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

(i) Bent's Rule and its applications

(ii) Aufbau principle and its limitations

(iii) Hund's rule of maximum multiplicity and its significance (5,5×2)

[This question paper contains 8 printed pages.]

Your Roll No.

Sr. No. of Question Paper : 5979 **K**

Unique Paper Code : 2172011103

Name of the Paper : DSC: Gaseous and Liquid State (Physical Chemistry I)

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

Semester : I

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. Use of a scientific calculator and log table is allowed.
3. Attempt **Four** questions out of **six**, question no. **1** is compulsory.

(R = 8.314 J K mol^{-1}, k = 38 × 10^{-23} J K^{-1}, N_A = 6.023 × 10^{23} mol^{-1})

P.T.O.

(c) The coefficient of viscosity of n-heptane is 0.0001328 Poise at 298 K. Calculate the molecular diameter of this gas. Molecular mass of n-heptane is 100 g mol^{-1}. (5)

3. (a) Calculate the pressure of a barometer on an aeroplane which is at an altitude of 10 km. Assume the pressure to be 101.325 kPa at sea level and the mean temperature 243 K. Use the average molar mass of the air (80 % N_2 and 20% O_2). (5)

(b) The mean free path of the molecule of a certain gas at 300 K is 2.6×10^{-6} m. The collision diameter of the molecule is 0.26 nm. Calculate pressure of the gas and the number of molecules per unit volume of the gas. (5)

(c) Using van der Waals equation, define and calculate the critical constants. Also explain with PV diagram the continuity of state.

(5)

4. (a) Write an expression of Maxwell Distribution of speeds. Convert this expression into Energy Distribution. Show the plots of these distribution as variation of speed and energy.

(5)

(b) Write the cubic form of van der Waals equation and compare with the given equation for the calculation of 2nd Virial coefficient.

$$Z = 1 + A_1p + A_2p + A_3p^2 + \ldots.$$ (5)

(c) At 20°C, pure water with an absolute viscosity of 1.002×10^{-3} Nm^{-2} s requires 102.2 s to flow through the capillary of an Ostwald viscometer. At 20°C, toluene requires 68.9 s. If the densities of water and toluene be 0.998 and 0.866 g cm^{-3}, respectively, calculate the viscosity of toluene.

(5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 12572 **K**

Unique Paper Code : 2174001001

Name of the Paper : Atomic Structure and Chemical Bonding

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

Semester : I/III/V/VII

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) Define exchange energy. The expected electronic configurations of Cr and Cu differ from the observed electronic configurations. Explain.

(b) Draw the radial probability distribution curves for 3s, 3p and 3d orbitals.

(c) Write the Schrodinger wave equation and explain the various terms involved in it. What are the conditions that should be fulfilled to become an acceptable solution to the wave equation?

(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-flaber 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 one mole $Br_2(g)$ = 193 KJ/mol

(iv) Ionization energy of magnesium = 2187 KJ/mol

(v) Electron affinity of bromine = -331 KJ/mol

(vi) Heat of formation of magnesium bromide ($MgBr_2$) = -524 KJ/mol

(c) Define polarising power. Which cation has greater polarising power?

(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 following structures (any two) :

(i) NH_3

(ii) $XeOF_4$

(iii) ClF_3

(c) The dipole moment of the molecule HX is 1.92D, and the bond distance is 1.2Å. Calculate the percentage ionic character of HX. How does molecular geometry affect the dipole moment? (5,5,5)

4. (a) Explain any two applications of Born Haber's Equation.

P.T.O.

(b) Explain, giving reasons :

(i) s-orbitals are spherical symmetrical.

(ii) MgO has a higher melting point than NaCl according to lattice energy.

(c) Explain Valence Bond Theory (VBT) for covalent bonding. (5,5,5)

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

(b) Why in SF_6, 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 energy 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) Hund's Rule of maximum multiplicity.

(ii) Fajan's Rule

(iii) Solvation energy

(iv) Orthogonal and Normalized Wave functions. (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5725 **K**

Unique Paper Code : 2172012301

Name of the Paper : Chemistry of d & f block elements and quantitative inorganic analysis

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

Semester : III

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. Explain the following by giving reasons.

   (a) Although gold and platinum have lower ionization enthalpy then 3d transition elements yet they are noble metals. Explain.

   (b) Lanthanoids show sharp bands in the adsorption spectra in contrast to transition elements. Explain

   (c) Why zinc, cadmium and mercury are not considered as a transition element.

   (d) The +3 oxidation state of Lanthanum (Z=57), Gadolinium (Z=64) and Lutetium (Z=71) are especially stable. Why?

   (e) Among $TiCl_4$, VCl_3 and $FeCl_2$, which one will be drawn more strongly into the magnetic field and why. (3×5)

2. (a) Discuss the preparation, properties and structure of polyphosphonitrilic chloride molecule $[NPCl_2]_3$.

P.T.O.

(b) Explain silicon rubber. What are the chain building and chain stopping units in silicon?

(c) Write the polymerization process for dialkyl dihydroxy silane.

(d) What is the difference between co precipitation and post precipitation?

(5,5,2.5,2.5)

3. (a) Draw the structure of the following :

(i) Borax

(ii) $Ni(DMG)_2$

(iii) Dimethyl silicon oil

(iv) $Si_4O_{11}^{6-}$

(v) SiO_3^{2-}

(b) Which is stronger base $La(OH)_3$ or $Lu(OH)_3$. Why?

(c) What is meant by heating to constant weight and why is it important?

(d) Draw the plot for X Vs T (K) for ferromagnetic substance.

(e) Magnetic susceptibility of ferromagnetic and antimagnetic can be calculated by _____ law. (5,2.5,2.5,2.5,2.5)

4. (a) Consider the Latimer Diagram for Mn in Acidic Medium.

$$MnO_4^- \xrightarrow{+0.56V} MnO_4^{-2} \xrightarrow{+2.26V} MnO_2 \xrightarrow{+0.95V} Mn^{3+} \xrightarrow{+1.51V} Mn^{2+} \xrightarrow{-1.19V} Mn$$

Answer the following questions :

(i) Is there any tendency of Mn^{2+} to reduce to Mn? Give reasons.

(ii) Calculate skip step EMF for MnO_2 to Mn^{2+}.

(iii) Which oxidation state of Mn are likely to disproportionate?

(iv) Which is most stable species?

(v) How is Latimer diagram different from Ebsworth?

(b) Describe giving reason which one of the following part has the property indicated :

(i) Cr^{2+} or Fe^{2+} (stronger reducing agent).

(ii) Co^{2+} or Ni^{2+} (lower magnetic moment) (10,2.5×2)

5. (a) Arrange the following monoxides of transition metal on the basis of decreasing basic character.

TiO, VO, CrO, FeO

(b) Actinides display a variety of oxidation states in comparison to that of lanthanides. Explain.

(c) What is super saturation? How does the phenomenon of supersaturation affect the formation of particles in a solution?

(d) Calculate the magnetic moment of Europium (III) (L=3). Explain the discrepancy between observed (3.4-3.6 BM) and calculated value of magnetic moment. (2.5,2.5,5,5)

P.T.O.

6. Write a note on **(Any Three)** :

(i) Phosphates

(ii) Lanthanide contraction and its consequences.

(iii) Separation of Lanthanides by cation exchange chromatography.

(iv) Catalytic properties of transition element. (5×3)

(2000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5803 **K**

Unique Paper Code : 2172012302

Name of the Paper : DSC Carbonyls, Carboxylic Acids, Amines, Nitro Compounds, Nitriles, Isonitriles And Diazonium Salts

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

Semester : III

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 any **SIX** Questions out of **EIGHT**.
3. All parts of a question should be attempted together.
4. Each question carries **15** marks.

P.T.O.

1. (a) A resolvable amine (A) is subjected to Hoffman Exhaustive Methylation with Mel to give (B). (B) When subjected to Hoffman Elimination gives an alkene (C). On reductive ozonolysis the isolated alkene (s) yield on equimolar mixture of Methanal and Butanal. Deduce the structure of A, B and C. Write the all reactions. (6)

(b) Write action of heat on α, β, γ and δ hyroxyacids. (4)

(c) Write the relative order of the following acid derivatives towards nucleophilic substitution reactions

$RCONH_2$, RCOCl, RCOOR', RCOOCOR' (3)

(d) Which is more acidic :

Malonic Acid or Acetic Acid (2)

2. (a) Write the synthesis of the following from Acetoacetic ester **OR** malonic ester **(any three)**

(i) γ-Keto valeric acid

(ii) Acetyl Acetone

(iii) Adipic Acid

(iv) α-Methyl succinic acid (3×2=6)

(b) How will you differentiate between?

(i) $C_6H_5COCH_3$ and Cyclohexanone

(ii) C_6H_5 $CONH_2$ and $C_6H_5NH_2$ (2×2=4)

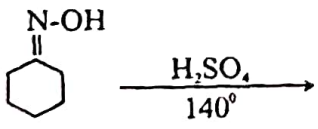
(c) Write the increasing order of reactivity towards nucleophile addition reaction give reason :

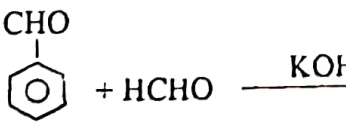
HCHO, CH_3COCH_3, CH_3CHO (3)

(d) Why the presence of a small amount of acid increases the nucleophile addition reaction in carbonyl compounds. (2)

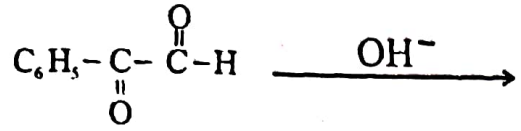
3. Predict the product and name of reaction involved :

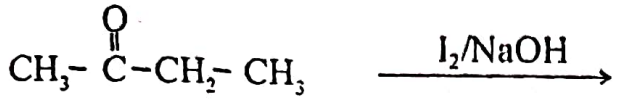
(i) $C_6H_5CHO + (CH_3CO)_2O \xrightarrow{CH_3COONa}$ .....

(ii) 

(iii) 

(iv) $CH_3 - CH{=}CH{-}CH_2OH \xrightarrow{PDC}$ .....

(v)  .....

(vi)  .....

(vii) $C_6H_5 - CH=CH - COOC_2H_5 + H_2C(COOEt)_2 \xrightarrow{EtONa}$ .....

(15)

4. (a) An organic compound A (C_4H_9NO) on treatment with bromine and aq. NaOH forms compound B (C_7H_9N). (B) on treatment with $NaNO_2$ and dil HCl gives C (C_3H_8O) along with the evolution of N_2 gas. (C) forms Iodoform with Iodine and aq. Na_2CO_3. Identify (A), (B), (C). Give sequence of reaction and name reaction involved in (A) to (B). (6)

(b) Convert **(Any two)**

(i) Aniline to Fluorobezene

(ii) Aniline to p-Nitroaniline

(iii) Nitrobenzene to m-Nitrophenol. (2×2=4)

(c) Explain :

Addition of Ammonia derivatives to carbonyl compounds requires an optimum pH 3.5. (3)

(d) Write Sandmeyer's reaction to synthesise Iodobenzene. (2)

5. (a) Arrange the following in order of decreasing basic strength (Give Reason) :

(i) o-Anisidine

(ii) p-Nitro aniline

(iii) o-Nitro aniline

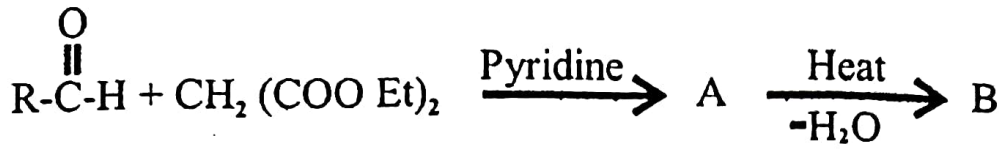
(iv) Aniline (6)

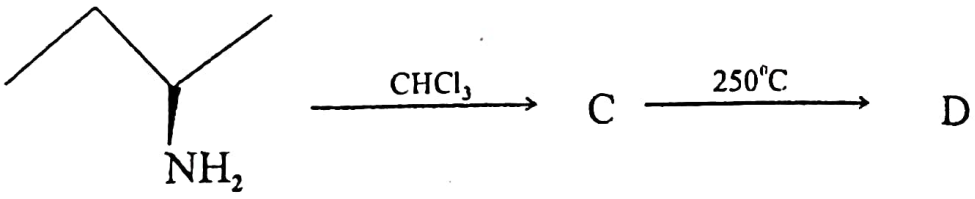
(b) Nitrobenzene and Aniline do not undergo Friedal Craft reaction explain. (4)

(c) Explain how Hoffman Elimination can be used for distinguishing 2-methyl pyrrolidine and 3-methyl pyrrolidine. (3)

(d) Write the specific role of cyanide ion in Benzoin condensation. (2)

6. (a) Complete any two of the following reaction. Write the name reaction wherever involved.

(i) 

(ii) 

(iii) $RCH_2COOH + Br_2/Red\,p \longrightarrow E \xrightarrow{NaOH} F$

(3×2=6)

(b) Convert the following :

(i) Aniline to 1, 3, 5 – tribromobenzene

(ii) Acetanilide to o-dinitrobenzene (2×2=4)

(c) Explain why acid chloride is more reactive than alkyl halide towards nucleophilic substitution reactions. (3)

(d) How will you convert nitrobenzene into p-amino phenol. (2)

7. (a) Explain any **three** :

(i) How can one distinguish between aniline, diethyl amine and triethylamine using Nitrous acid? Give the reaction involved.

(ii) Nitriles are less basic than primary amine.

(iii) Cope elimination of amine oxide is cis elimination reaction.

(iv) Strong acidic or strong basic condition prevent coupling reactions of arylamines.

(3×2=6)

(b) Synthesise Ethyl acetoacetate by Claisen condensation. Write the mechanism involved. (4)

(c) What is an active methylene compound? Give one examples other than Malonic ester and Ethyl acetoacetate. (3)

(d) N-Ethyl, N-methyl amine is chiral but non resolvable. However $C_6H_5N^+$ (CH_3) (C_2H_5) (C_3H_7) Cl^- is resolvable. (2)

8. Write short notes **(any three)**

(i) Benzilic acid rearrangement

(ii) Hoffmann Bromamide reaction

(iii) Hinsberg's test

(iv) Henry reaction

(v) Benzoin Condensation (5×3=15)

(6)

[This question paper contains 4 printed pages.]

Your Roll No.....

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

Unique Paper Code : 2172012303

Name of the Paper : DSC: Chemical Equilibrium, Ionic Equilibrium, Conductance and Solid State

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

Semester : III

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 any **Six** questions in all.
3. Question No. **1** is compulsory.
4. Use of scientific calculator is permitted.

1. Attempt any **five** :

(a) What is Walden's rule? Explain, why is it not applicable to cations of small size.

(b) For the reaction, $SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$ at 25°C, the standard molar Gibb's free energy of formation (ΔG_f^o) of $SO_2(g)$ and $SO_3(g)$ are -300 kJ mol^{-1} and -371 kJ mol^{-1}. What will be the equilibrium constant (K_p) at this temperature? (R = 8.314 J mol^{-1} K^{-1})

(c) How is conductivity water prepared? The specific conductance of a solution prepared in this conductivity water is 0.176 Ω cm^{-1} If the cell constant is 0.225 cm^{-1}, calculate the conductance (Ω^{-1}) of the solution.

(d) What is the ionic product of water? Comment on "pH of water is 7 at 25°C but at other temperature, it may be more or less than 7.00".

(e) What will be the entropy of mixing (JK^{-1}) when three moles of helium are mixed with one mole of neon at constant temperature and pressure (25°C and 1 atm.)?

P.T.O.

(f) What is the buffer solution? Explain it with appropriate examples.

(g) Explain the law of rational indices and the law of symmetry?

(3×5=15)

2. (a) Derive the quantitative equations of Le Chatelier's principle. With the help of the principle, comment on the conditions of temperature and pressure that would favour the formation of nitric oxide in the following reaction.

$N_2(g) + O_2(g) \rightleftharpoons 2\,NO\,(g)$; $\Delta H^o = 180.75$ kJ

(b) What is meant by the degree of advancement of a chemical reaction and derive the law of chemical reaction for the ideal gas reaction, $2A\,(g) + B\,(g) \rightleftharpoons 3C\,(g)$.

(c) Show with a diagram that the greatest decrease in Gibbs free energy on mixing is associated with formation of mixture having equal number of moles of two constituents.

(d) Calculate the equilibrium constant (K_C) for a reaction, $2SO_2(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ for which K_p is 3.5×10^{-23} atm at 27°C and the gas constant (R) is 0.082 dm^3 atm mol^{-1} K^{-1}. (4,4,4,3)

3. (a) Show that the pH of a hydrolysed salt from a weak acid and a weak base can be determined through following equation:

$$pH = \frac{1}{2}\,pK_w + \frac{1}{2}\,pK_a - \frac{1}{2}\,pK_b$$

(b) A buffer solution is made of 0.2 moles of HA and 0.25 moles of NaA per litre. Calculate the change in pH of the solution if 0.1 mL of 1 M NaOH is added to it. Assume that the volume of the buffer remains unchanged. Provided: ($k_{HA} = 1.0 \times 10^{-5}$).

(c) Calculate the solubility in grams per litre of $Al(OH)_3$ in water at 25°C when its solubility product is 8.5×10^{-32}.

(d) The base ionization constant (k_b) of ammonia in water is 1.8×10^{-5}. What should be the value of acid ionization constant (k_a) of the conjugate acid? (4,4,4,3)

4. (a) What is meant by transport number of an ion? Explain the factors on which the transport number of an ion depends?

(b) The conductivities of water and a saturated solution of a sparingly soluble salt, AB_2 are 7 and 21 $\mu S\ m^{-1}$ and ionic conductivities of cation and anion of AB_2 are 12.72 $\mu S\ m^2\ mol^{-1}$ and 7.64 $mS\ m^2 mol^{-1}$. What is the solubility of AB_2?

(c) The specific conductance of 0.01 M solution of acetic acid was found to be 0.01 $\Omega^{-1}\ m^{-1}$. Calculate the degree of dissociation of the acid when the limiting molar conductance of acetic acid is $400 \times 10^{-4}\ \Omega^{-1}\ m^2 mol^{-1}$.

(d) In the electrolysis of Al_2O_3 in the solvent of Na_3AlF_6, assuming that the deposition of Al is the only cathodic reaction, how much time (in hour) will be required to deposit 100 g of Al at a current density of 125 A?

(4,4,4,3)

5. (a) Compute the Miller indices for a face having having intercepts on the following three axes and prove that the Miller indices are the same.

(i) (2a, b, ∞c) (ii) (4a, 2b, ∞c)

(b) A grating with 4000 lines cm^{-1} is illuminated with Hg green line having a wavelength equal to 546 nm. At what angle will the first and second order diffraction maxima occur?

(c) Derive the Bragg's equation, $n\lambda = 2d \sin 0$. For the reflection of X-rays from the faces of a crystal and show that it can be written as $\lambda = 2\ d_{hkl} \sin \theta$.

(d) What is the lattice parameter 'a' of a cubic crystal system when the powder X-ray diffraction pattern recorded using Cu Kα source (λ = 1.54 Å) shows a peak at 33.60° (2θ) for (111) plane? (4,4,4,3)

6. (a) How will you determine the solubility of a sparingly soluble salt by Conductance measurement?

(b) Write short notes on any two of the following types of cubic lattices. In each case, describe their characteristic features and structure with suitable diagrams:

(i) Simple cubic lattice

(ii) Body-centred cubic lattice

(iii) Face-centred cubic lattice

P.T.O.

(c) Why Phenolphthalien cannot be used as an indicator in titration between a strong acid and a weak base? Discuss the pH metric titration of a strong acid and a weak base using a suitable indicator.

(d) For the reaction, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, show that the equilibrium constant (K_p) is given by :

$$K_P = \frac{\alpha^2 P}{1-\alpha^2}$$

where a is the degree of dissociation and P is the total pressure.

(4,4,4,3)

7. (a) Describe briefly how is the conductometric titration used for titration (i) between a strong acid and a weak base (ii) between a weak acid and strong base.

(b) What are the symmetry elements present in a cubic crystal?

(c) Explain the terms: (i) Asymmetry effect (ii) Electrophoretic effect.

(d) In a reaction, 2A (g) + 3B (g) $\rightleftharpoons$ 2C (g) at a given temperature, when 2.0 moles of A (g) are reacted with 2.0 moles of B (g), 0.8 moles of C (g) are formed at equilibrium at a total pressure of 2.0 bar. What will be the equilibrium constant (K_p) of this reaction at the given temperature?

8. (a) Discuss the Debye Scherrer method for determining the crystal structure. Explain how it can be used to study the simple cubic, body-centred cubic and face-centred cubic crystals.

(b) The dissociation constant of HCN at 25°C is found to be 4.8×10^{-10} M. What will be hydrolysis constant, degree of hydrolysis and pH of 0.25 M NaCN solution?

(c) Metallic silver crystallizes in face-centered-cubic lattice structure with a unit cell length 40 nm. The first order diffraction angle of X-ray beam from (2,1,0) plane of silver is 30°. What is the wavelength of X-ray used?

(d) A 0.05 KOH solution offered a resistance of 31.6Ω in a conductivity cell of cell constant of 0.316 cm^{-1}. Calculate the molar conductance of KOH solution.

(4,4,4,3)

(2000)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3324 **K**

Unique Paper Code : 32171501

Name of the Paper : DSC (Organic Chemistry-IV) Biomolecules

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

Semester : V

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. Attempt any **Six** questions.
3. All parts of a question should be attempted together.
4. Each question carries **12.5** marks.

1. (a) Differentiate between nucleotides and nucleosides. Draw the structure of purine bases.

   (b) Differentiate between competitive and non-competitive inhibition.

P.T.O.

(c) Define Saponification value and give its importance. Calculate the saponification value of glyceryl tristearate having molecular weight 891 (molecular weight of KOH = 56). (4,4,4.5)

2. (a) Define Isolectric point and give its significance. Calculate the isoelectric point of glutamic acid from the following data: pKa_1 =2.19, pKa_2 = 4.25 and pKa_3 = 9.67.

(b) Write down the reaction of Glucose with (i) HNO_3, (ii) HIO_4

(c) Explain the process of DNA replication.

(4,4,4.5)

3. (a) Give the synthesis of Alanine using Malonic ester synthesis.

(b) Write the schematic representation of Krebs cycle. Mention the enzymes involved in the process.

(c) Explain why Glucose, Fructose and Mannose give the same Osazone? Give the mechanism of Osazone formation starting from glucose.

(4,4,4.5)

4. (a) What is Chargaff's rule. Discuss its significance.

(b) Write the full form and structure of ATP. Explain why, ATP is called the universal currency of cellular energy.

(c) List six main groups of enzymes according to the Enzyme commission. Briefly describe the function they perform. (4,4,4.5)

5. (a) What are the different types of RNA. Explain the role of any one of them.

(b) Give the steps and enzymes involved in the conversion of glucose to glyceraldehyde-3-phosphate during glycolysis.

(c) How will you synthesize the tripeptide Gly-Ala-Val using Merrifield solid phase synthesis. Discuss the advantages of this method over other conventional methods? (4,4,4.5)

6. (a) Explain the term hardening of oil by taking suitable example.

(b) Give the structure of amino acid which :

(i) gives yellow color with ninhydrin

(ii) has sulphur in the side chain

(iii) has -OH in the side chain

(iv) has -COOH in the side chain

(c) Explain Edman's method of N-terminal analysis. What is the advantage of this method over Sanger's method for N-terminal analysis of peptides? (4,4,4.5)

7. (a) Draw the structural formula of tripeptide glycylalanylphenvlalanine and indicate the C-terminal and N-terminal amino acids.

(b) Define Enzyme activity, and discuss the effect of substrate concentration on the activity of an enzyme.

(c) Explain the process of Electrophoresis. How can it be used to separate a mixture of amino acids. (4,4,4.5)

8. Write a short notes on :

(a) Mechanism of action of Chymotrypsin

(b) Watson and Crick model of DNA

(c) Secondary and Tertiary structure of proteins (4,4,4.5)

SL NO of QP:3534
Unique Paper Code : 32177903
Name of the Paper : DSE-II Applications of Computers in Chemistry
Name of the Course : B.Sc.(Hons.) Chemistry
Semester : V
Duration : 3 hours
Maximum Marks : 75

Instructions for Candidate

*1. Attempt only **Six Questions in All.***
*2. **Question Number 1 is compulsory.** Attempt any five questions out of remaining seven questions.*
3. Attempt all parts of a question together.
4. Use of Non- programmable scientific calculator and logarithm table is allowed.

1. Attempt all parts.

a. Explain the following Q-BASIC Statements
   i. CLS
   ii. DIM
   iii. RESTORE

b. Write the full form of the following abbreviations
   i. QBASIC
   ii. IPO
   iii. BCD
   iv. BIT

c. .Write the following algebraic expressions in BASIC
   i. $v = \frac{\pi ptr^4}{8l}$
   ii $G° = -RT\ ln\ ln\ Kc$
   iii $y = a_1 + a_2x + a_3x^2$
   iv $E = E_0 - \frac{2.303RT}{nF} log(\frac{a_{red}}{a_{ox}})$
   v $x = \frac{27Rb^2l^2}{64a}$

d. Identify the errors (if any) in the given numeric/string variables.
   i. NEXT
   ii. TEMP!
   iii. 123$
   iv. FIVE$(6)
   v. TWO-WAY
   vi N95 (3,4,5,3)

2 a. Write the BASIC statements to produce the following effects
   i. Assign the value represented by the variable A to the variable B
   ii. Reserve 9 spaces in a single array
   iii If variable y has value less than equal to 50 then transfer control to 80 otherwise execute next statement
   iv. Find Cosine of angle C

b. Write a program in QBASIC to calculate the sum of first 20 even numbers.

c. Write the syntax of the following commands with one example.
   i. PSET
   ii. LINE (4,4,4)

3.

a. Convert the following
   i. $(422.125)_{10}$ to binary.
   ii. $(11101.1101)_2$ to decimal.

b. Differentiate between relational and logical operators.

c. Write output of the following program.

```
10 CLS
```

```
20 INPUT "ENTER THE NUMBER=" ; N
30 PRINT
40 FOR I = 1TO 10
50 T = N*I
60 PRINT N; "*" ; I; "=" ;T
70 NEXT I
80 END
```

(4,4,4)

4 a. Difference between Print Semicolon and Print Comma, Print TAB(X) and LOCATE command.

b. What would be the output of following program.

```
SCREEN 1
PSET (40,40)
FOR J = 5 TO 25 STEP 5
CIRCLE (40,40) ,J
NEXT J
END
```

How would the output change if same program is written in SCREEN 2? How will you change the colour of the circle.

c. Write a short note on the first and third generation of computers. (4,4,4)

5.

a. Write a program in QBASIC to determine the roots of the given equation using Iterative method. $x^3 + 8x^2 - 10 = 0$

b . Explain with examples the differences between USER DEFINED Functions and Library Functions in QBASIC.

c. Illustrate the difference between INPUT and READ....DATA statement by giving examples.

(4,4,4)

6 a. Identify the errors in the following program. Write the correct program.

```
20 CLS: SCREEN '640*480
25 LOCATE (5,25): PRINT IDEAL GAS ISOTHERMS
30 VIEW (-100,100) - (500,400) ,,7
40 FOR T=200 TO 500 STEP 20
50 FOR V= 0.05 TO 0.5 STEP .0001
60 P=0.0821 *T/V
65 PSET V,P
70 NEXT T
80 END
```

b. What is the difference between computer screen coordinates and world coordinates? Give the syntax for changing screen coordinates to world coordinates.

c. What is the significance of Operating System. Name any two operating system. (4,4,4)

7 a. Explain with example (any two)

i. Syntax error
ii. Subscript out of range
iii. Type mismatch

b. Write a program in BASIC to read and print the following matrix and then carry out the transpose of following matrix. |3 4 5 6 7 8 1 7 9|

c. Write differences between BIT, BYTE and NIBBLE.

(4,4,4)

8 a. Differentiate between High level language and Machine Language.

b. Identify which of the following statements, if any are written incorrectly and write their correct form

i. ON N$ GOTO 10, 20, 30
ii. IF X^2 < 0 THEN 20
iii. FOR I = 10 TO 0 STEP 2

iv. FOR K$= 1 TO L STEP2

c. Write a program in BASIC to assign "CHEMICAL THERMODYNAMICS" to string variable X$, extracting required string constants from X$ using only string functions/commands print "THERMODYNAMICS CHEMICAL" (Note-None other string constants to be used).

(4,4,4)

(9)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5706 **K**

Unique Paper Code : 2172013501

Name of the Paper : BASICS OF ORGANOMETALLIC CHEMISTRY

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

Semester : V

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 number **1** is compulsory.
4. Each question carries equal marks.

1. Complete the following :

   (a) An example of a sandwich compound is .....

   (b) An example of Schrock carbene is .....

   (c) Number of C-O stretching vibrations observed for C-O in IR region for $Fe_2(CO)_9$ are .....

   (d) Effective atomic number of $V(CO)_6^-$ is .....

   (e) An example of a ligand with three hapticity (η^3) is .....

   (f) The catalyst used in the hydroformylation reaction is .....

   (g) Give an example of nucleophilic substitution reaction in organometallic chemistry.

   (h) Draw the structure of $Mn_2(CO)_{10}$.

   (i) A catalyst with a lower turnover frequency is an efficient catalyst (True/ False).

P.T.O.

(j) Geometry and hybridisation of $Fe(CO)_5$ as per VBT is .....

(k) Non bonding orbitals in MO diagram of $Co(CO)_6$ are .....

(l) Migratory insertion of a coordinated alkene in M-H bond leads to formation of ..... (alkane/alkyne).

(m) The value of x in $Mn(CO)_xCl$ is .....

(n) C-C stretching frequency in $H_2C=CH_2$ is ..... (higher/lower) than Zeise's salt.

(o) Define metallacycles. (1×15=15)

2. (a) Based on 18 electron rule, identify the charge, x on coordination sphere for the following complexes :

(i) $[HFe(CO)_4]^x$

(ii) $[Mn(CO)_3(PMe_3)_2Cl]^x$

(b) Giving reasons arrange the following in the order of increasing M-C bond strength

(i) $[Mn(CO)_6]^{2+}$, $[Cr(CO)_6]^+$, $[V(CO)_6]$

(ii) Does the M-CO bond strength increase or decrease when L of $[L_nM-CO]$ becomes more electron withdrawing? Justify your answer.

(c) Differentiate between metal aikene and metal alkyne compounds giving examples for each. (5×3=15)

3.. Provide a suitable explanation for the following statements :

(a) Fischer carbenes are less reactive than Schrock carbenes.

(b) For a homogeneous catalyst, the nature of ligands attached to the metal, influences its reactivity and selectivity.

(c) $Co(\eta^5\text{-}Cp)_2$ complex is much more readily oxidised than $Fe(\eta^5\text{-}Cp)_2$.

(d) Electrophilic substitution in ferrocene often occurs more readily than in benzene.

(e) $Fe_2(CO)_9$ and $Mn_2(CO)_{10}$ are both dimeric carbonyls, yet their structures are not identical. (5×3=15)

4. (a) Give catalytic cycle for Monsanto acetic acid process clearly marking the type of reaction at each step.

(b) Differentiate (giving examples) between

(i) Hapticity and Denticity

(ii) Homogeneous and heterogeneous organometallic catalyst

(c) Using VBT, deduce the structure of

$Mn_2(CO)_{10}$, $Ni(CO)_4$. (5×3=15)

5. (a) Describe two preparative methods for metal carbonyls with the help of examples.

(b) C-O stretching frequency for free CO is 2143 cm^{-1} while for the carbonyls $[Ti(CO)_6]^{2-}$, $[Cr(CO)_6]$ and $[Fe(CO)_6]^{2+}$ are 1748, 2000 and 2204 cm^{-1} respectively. Explain.

(c) Describe Dewar-Chatt-Duncanson model of bonding in Zeise's salt. Explain its structure also. (5×3=15)

6. (a) Complete the following chemical equations :

(i) $Mn_2(CO)_{10} + Na \rightarrow ?$

(ii) $Re_2O_7 + CO \rightarrow ?$

(iii) $WCl_6 + CH_3Li \rightarrow ?$

P.T.O.

(iv) $K_2[PtCl_4] + H_2C=CH_2 \rightarrow ?$

(v) $Fe(CO)_5 + P(CH_3)_3 \rightarrow ?$

(b) Metallocenes generally violate $18e^-$ rule and yet are stable compounds. Explain.

(c) (i) Coordinatively saturated organometallic complexes containing β hydrogen are thermally more stable towards β-elimination reactions than the unsaturated analogues. Explain

(ii) Oxidative addition to a catalyst increases its electron count. Explain giving an example. (5×3=15)

7. (a) Using MO diagram of CO, explain the synergistic bonding in M-C bond in metal carbonyls.

(b) Give one method of preparation of Ferrocene. Explain its aromatic character. Why does Ferrocene undergo acetylation reaction easily compared to benzene? Give equation and mechanism for Mannich reaction of acetylferrocene with HCHO and $(CH_3)_2NH$.

(c) What information can be drawn from cyclic voltammogram of ferrocene? (5×3=15)

8. (a) (i) Explain the role of alcohol in the synthesis of tetramminecopper(II) sulphate complex.

(ii) Why can't you obtain the crystals of the above complex by concentrating the mother liquour?

(b) Explain giving examples (i) migratory insertion of carbonyl (ii) Oxidative addition in a catalyst.

(c) Explain the mechanism of zeigler Natta polymerisation of ethene. (5×3=15)

(10)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5783 **K**

Unique Paper Code : 2172013502

Name of the Paper : NUCLEIC ACIDS, AMINO ACIDS, PROTEINS AND ENZYMES DSC 14

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

Semester : V

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. **All** questions have equal marks
3. Attempt any **four** questions in all.

P.T.O.

1. (i) Repeated Edman degradations of the hexapeptide Ala-Phe-Ser-Val-Trp-Gly yielded an amino acid derivative 'A' and a peptide 'B' after the first cycle and an amino acid derivative 'C' along with a peptide 'D' after the second cycle. Write all the reactions involved in these two cycles of Edman degradation. Label the structures A, B, C and D.

(ii) What are different types of RNA? Discuss their biological functions.

(iii) List the six main groups of enzymes according to the Enzyme Commission. What functions do they perform? (5,5,5)

2. (i) What are the products formed when the hydrolysis of the following peptide is catalyzed by the enzyme a) Trypsin and b) Chymotrypsin

Ser---Phe---Tyr---Lys---Val---Trp---Arg---Gly---Tyr

(ii) What is the difference between a competitive and noncompetitive enzyme inhibition?

(iii) What is DCC and what role does it play in peptide synthesis? Discuss with an example.

(iv) What are essential amino acids? Name any two giving their structure. (4,4,4,3)

3. (i) Explain the mechanism of action of the enzyme Trypsin.

(ii) Write the names and draw the structures of nitrogenous bases present in DNA. What is the name of the sugar moiety present in DNA?

(iii) Briefly describe the factors affecting enzyme activity. (5,5,5)

4. (i) How does carboxypeptidase enzyme help with peptide chain C-terminal residue analysis?

(ii) How would you synthesize the tripeptide Ser-Phe-Ala using solid phase peptide synthesis?

(iii) Explain the principle of electrophoresis. How do we separate a mixture of amino acids using electrophoresis? Discuss with example. (4,6,5)

5. (i) Differentiate between :

(a) α-Helix and β-pleated sheets

(b) Lock and Key Model and Induced Fit Model of Enzyme Action

(ii) Write the names and draw the structures of all the dipeptides formed using the two amino acids Phe and Gly.

(iii) Discuss a method to synthesize (D, L)–Tyrosine

(iv) Why is DNA replication semiconservative in nature? (4,4,4,3)

6. Write short notes on the following : **(Any 3)**

(i) Translation and Transcription

(ii) Denaturation of proteins

(iii) Importance of Ninhydrin reagent

(iv) Genetic Code (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5841 **K**

Unique Paper Code : 2172013503

Name of the Paper : QUANTUM CHEMISTRY AND COVALENT BONDING

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

Semester : V

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 any **six** questions out of **eight**.
3. Attempt all parts of a question together.
4. Use of scientific calculators and log tables is allowed.

Physical constants

Atomic mass unit	:	1.66×10^{-27} kg
Planck's constant	:	6.626×10^{-34} J s
Velocity of Light	:	3×10^{8} m s^{-1}
Boltzmann constant	:	1.381×10^{-23} J K^{-}
Mass of Electron	:	9.1×10^{-31} kg
Avogadro's number	:	6.022×10^{23} mol^{-}

Standard Integrals

$\int_0^\infty x^n e^{-ax} dx = \frac{n!}{a^{n+1}}$ for $n > 1$

$\int_0^\infty e^{-ax^2} dx = \left(\frac{\pi}{4a}\right)^{1/2}$

$\int_0^\infty x^{2n} e^{-ax^2} dx = \frac{1.3.5...(2n-1)}{2^{n+1}a^n}\left(\frac{\pi}{a}\right)^{1/2}$ for $n > 1$

1. (a) (i) Write the properties of a function that make it acceptable as a wave function solution of Schrodinger wave equation.

(ii) A particle in a one-dimensional box moving under a constant potential in a space has no boundaries. Will the energy be quantized in such a case? Explain.

(b) Apply the variation theorem to the wave function $\psi(x) = x(L^2 - x^2)$, where $0 \leq x \leq L$ to a particle of mass m in a one-dimensional box and estimate the ground state energy. Is the wave function a suitable choice for a particle in a one-dimensional box problem? Explain.

(c) Naphthalene may be considered to be a rectangle of length 0.8 nm and breadth 0.4 nm. Write the wave function corresponding to the highest occupied level for naphthalene. Using free electron model calculate the energy required by the electron to go to the first excited state.

(5,5,5)

2. (a) A particle of mass 'm', attached to a flexible spring, undergoes simple harmonic oscillations.

(i) Give the expression for energy level based on quantum mechanical treatment.

(ii) What is the energy difference (ΔE) between two successive energy levels?

(iii) What is the zero point energy of the system? Explain its significance.

(b) Given that the ground state normalized wave function for the harmonic oscillator is

$$\psi_0 = \left(\frac{\sqrt{\alpha}}{\pi^{1/2}}\right)^{1/2} \exp\left(-\frac{\alpha x^2}{2}\right)$$

(i) Determine the value of x at which the ground-state function of the harmonic oscillator exhibits the maximum. Predict the value of x at which the probability of finding the particle is maximum. Compare this value with that predicted by the classical treatment.

(ii) Evaluate the expectation value of kinetic energy for harmonic oscillator in ground state.

(5,5,5)

3. (a) What are Hermitian operators? Show that the eigenvalues of a Hermitian operator are always real.

(b) Determine whether the following functions are eigen functions of the operator, $\hat{L}_z = -i\hbar\frac{d}{d\phi}$. Evaluate the eigen values if applicable.

(i) $\psi = \exp(im\phi)$

(ii) $\psi = 6\cos m\phi$

(c) Find the commutator of position operator ($\hat{x}$) and momentum operator ($\hat{p}_x$). What is its physical significance? State the name of the principle it verifies.

(5,5,5)

4. (a) Write the simplest trial wave functions for H_2 molecule using VBT and MOT. Compare the merits and demerits of the above two methods.

(b) Calculate the bond order of the following molecular ions and compare the strength of their bonds with their respective neutral molecules.

Be_2^+, Be_2^-, F_2^+, F_2^-

(c) Explain the molecular orbital formation in the LiH molecule using the LCAO approach with the help of MO diagram. Discuss the overlap of atomic orbitals involved and indicate which combinations lead to bonding and antibonding orbitals.

(5,5,5)

5. (a) A rigid rotator consists of two particles of mass m_1 and m_2 joined by a rigid rod of length, r. Based on classical treatment, show that the total energy of a rigid rotator is $L^2/2I$, where L is the angular momentum and I is the moment of inertia. How does this result differ from quantum mechanical result? Write the Schrodinger equation for the rigid rotator in spherical polar co-ordinates.

(b) Normalize the given wave function for Hydrogen atom:

$\Phi = A \exp(im\phi)$

What is the significance of quantum number 'm' with respect to hydrogen atom?

(c) Show that for hydrogen atom, the wave functions for 1s and 2s orbitals are orthogonal.

Given: $\psi_{1,0,0} = 2\left(\frac{1}{a_0}\right)^{3/2} \exp\left(\frac{-r}{a_0}\right) \cdot \frac{1}{\sqrt{4\pi}}$

and $\psi_{2,0,0} = \left(\frac{1}{2a_0}\right)^{3/2} \left(2 - \frac{r}{a_0}\right) \exp\left(\frac{-r}{2a_0}\right) \cdot \frac{1}{\sqrt{4\pi}}$

(5,5,5)

6. (a) Derive the following expression using LCAO-MO treatment for H_2^+, starting from trial wavefunction $\psi = C_1 1s_A + C_2 1s_B$:

$$E_+ = \frac{\alpha+\beta}{1+S}$$

(Here α is the Coulomb integral, β is the resonance integral and S is the overlap integral)

(b) What are the essential conditions for atomic orbitals to form bonds in homonuclear diatomic molecules? Which of the following atomic orbitals will overlap to form molecular orbitals in a homonuclear diatomic molecule?

(i) 1s and 2s
(ii) $2p_x$ and $3p_z$
(iii) 3s and $3p_z$

(c) Verify that the wave functions of a particle of mass 'm' in a one-dimensional box of length 'a' are orthonormal.

(5,5,5)

7. (a) Calculate the average distance of 2s electrons from the nucleus of hydrogen atom. The normalised wave function for 2s electron in hydrogen atom is

$$\psi_{2,0,0} = \left(\frac{1}{2a_0}\right)^{3/2}\left(2-\frac{r}{a_0}\right)\exp\left(\frac{-r}{2a_0}\right)\cdot\frac{1}{\sqrt{4\pi}}$$

(b) How does the study of particle in a three-dimensional box lead to the concept of degeneracy. Show with the help of energy level diagram.

(c) State the Born-Oppenheimer approximation. Write the Hamiltonian operator for Li atom after applying the Born-Oppenheimer approximation explaining all the terms.

(5,5,5)

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

(a) Configuration interaction

(b) Zeeman and anomalous Zeeman effect

(c) Bonding and antibonding molecular orbitals

(d) Bohr's Correspondance Principle

(5,5,5)

SL No of QP:5877
Unique Paper Code: 2173010008
Name of the Paper: DSE: NOVEL INORGANIC SOLIDS
Name of the Course: B.Sc. (H) Chemistry
Semester: V

Duration: 3 hours **Maximum Marks: 90**

Instructions for the Candidates
Attempt **six** questions in all. **All** questions carry equal marks.

1. (a) Match the desirable precursors characteristics with the method for synthesis of inorganic solids using Ceramic / Sol-Gel/ Hydrothermal/ Intercalation/Chemical vapour Deposition:

Precursor Characteristics	Synthesis Method
Volatile	
Non-Volatile	
Layered	
Alkoxides	
Mineralizer	

(b) Explain the basic principle of UV-Visible spectroscopy. What is the role of Beer–Lambert's Law in this technique?

(c) Why is NASICON categorised as a frame-work electrolyte? How the change from parent composition as $NaZr_2P_3O_{12}$ to $Na_{1+x}Zr_2P_{3-x}Si_xO_{12}$ enhances conductivity.
(5, 5, 5)

2. (a) What is the structural basis for a conducting polymer? Explain the role of doping in polyacetylene.
(b) What are ion exchange resins? How are these classified as cationic and anionic resins?
(c) Define matrix. Which materials can be used as matrix? Explain the role of matrix in composites. (5, 5, 5)

3. (a) Discuss the role of yttrium stabilized zirconia solid electrolyte in the working of solid oxide fuel cell.

(b) What is the difference in thermosets and thermoplastics in terms of molecular structures and behaviour in commercial polymer matrix composites? Give at least one example of each.

c) Describe the basic principles of the hydrothermal synthesis method. What are the advantages and disadvantages of this method? (5, 5, 5)

4. (a) What information about an inorganic solid is provided by X-ray diffraction technique? What is the role of Bragg's law in this technique.

(b) How does doping with bromine make $K_2Pt(CN)_4.3H_2O$ a one dimensional conducting complex? Why does the conductivity of the doped complex drop below 150 K?

(c) What is the significance of epitaxy and topotaxy modifications in synthesis of inorganic solids. Explain with reference to the synthesis of $MgAl_2O_4$ spinel by heat and beat method. (5, 5, 5)

5. (a) Give at least three mechanical properties of ceramics which make them suitable materials for diverse applications?

(b) (i) What makes the naturally occurring semi-precious stone lapis lazuli, an analogue of ultramarine pigment $Na_8[SiAlO_4]_6.(S_3)_2$ appear royal blue?
(ii) Which is the key quality that makes TiO2 a white pigment?

(c) What are the differences in characterization by Scanning electron microscopy and Transmission electron microscopy. (5, 5, 5)

6. (a) (i) What process brings change from sol to gel phase in sol–gel process.
(ii) What is the difference in Xerogel and Aerogel?

(b) What is meant by exchange capacity of an ion-exchange resin? What is the role of cross-linkage and its impact on exchange capacity in the resins?

(c) Which ion is responsible for conduction in Ag_2HgI_4 ?Why does its conductivity increase above 50 °C ? (5, 5, 5)

7. (a) Explain the Fourier-Transform Infra-red technique in characterization of materials.

(b) (i)What is the role of reinforcements in a composite material?
(ii) How do the particulate, fibre and laminar types of composites differ with each other?

(c) What are environmental effects on composites? (5, 5, 5)

8. Write short notes on any three of the following:
(a) Dynamic Light Scattering characterization technique
(b) Chemical Vapour Deposition method of synthesis of inorganic solids
(c) Applications of conducting polymers
(d) Inorganic Liquid Crystals
(e) Inorganic phosphors (5, 5, 5)

[This question paper contains 4 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 6012

Unique Paper Code : 2173012002

Name of the Paper : Inorganic Materials of Industrial

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

Semester : VII

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 compulsory.
4. **All** questions carry equal marks.

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

   (a) Define glass transition temperature.

   (b) What does the number 24-0-6 on a fertilizer bag represent?

(c) Give the importance of galvanization.

(d) Define a cell and a battery.

(e) Differentiate between earthenware and stoneware.

(f) What is the role of a separator in any battery?

(5×3)

2. (a) Differentiate between silicate and non-silicate glasses. What is the importance of annealing in the manufacture of glasses?

(b) Distinguish between a lithium battery and a lithium-ion battery. What is the role of a polymer in this type of battery?

(c) Name any one precursor that can be used to manufacture carbon fibers. What are the special properties of carbon fibers that make them suitable for applications in the aerospace industry?

(5,5,5)

3. (a) What is a fuel cell? What are its advantages and disadvantages? Explain the working of the molten carbonate fuel cell.

(b) Discuss the synthesis and applications of fullerenes with special reference to the C_{60} molecule.

(c) Differentiate between plastic paints and oil paints. Explain the drying mechanism for both types. (5,5,5)

4. (a) How did Portland cement get its name? Explain with chemical reactions the process of setting and hardening of Portland cement.

(b) Differentiate between the surface coating methods of carburizing and cementation.

(c) Explain the terms prilling and granulation with respect to fertilizers. What are the environmental concerns associated with excessive use of fertilizers? (5,5,5)

5. (a) Why are some oxides semi-conducting and some superconducting? Give examples.

(b) Explain the process of chrome plating and give its applications.

(c) Explain the reactions involved in the working of a lead-acid battery. Why is it important to maintain the specific gravity of sulphuric acid in the battery? (5,5,5)

6. (a) How does phosphate fixation take place in acidic and basic soils?

(b) What are the constituents of a varnish? Give the mechanism of drying.

(c) Define pigment volume concentration and critical pigment volume concentration. What should be the ideal pigment volume concentration of a paint? Give reason. (5,5,5)

7. (a) With reference to clay used in the manufacture of ceramics, explain the terms (i) Plastic limit (ii) Liquid limit and (iii) Plasticity index

(b) Differentiate between wax and polish.

(c) Write a short note on mixed fertilizers. Give an example. (5,5,5)

8. (a) Describe how urea and calcium ammonium nitrate fertilizers are produced and give their uses.

(b) Give the composition and applications of heat-retardant and fire-retardant paints?

(c) Define battery capacity. What is a tandem solar cell? (5,5,5)

[This question paper contains 2 printed pages.]

Unique Paper Code : 2173010037

Name of the Paper : DSE – Main Group Clusters: Basics and Applications

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

Semester : VII

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 six.
3. All questions carry equal marks (15 marks each).
4. The questions should be numbered in accordance with the number in the question paper.

Q1. (a) Define the clusters in elemental state. Classify them on the basis of element type with examples .

(b) What are carboranes? How are they classified? Give examples.

(c) Draw the structures of isomers of $C_2B_{10}H_{12}$. (5,5,5)

Q2. (a) Classify the following clusters as closo, nido, arachno, hypho, and klado: $C_2B_6H_{10}^-$, $NCB_{10}H_{11}$, B_7H_{11}, $SB_{10}H_{10}^{2-}$, $C_2B_9H_{11}^{2-}$.

(b) What are Wade–Mingos rules? Illustrate giving examples.

(c) Complete and balance the followingreactions:

(i) $B_5H_9 + NH_3 \longrightarrow$

(ii) $B_{10}H_{14} + OH^- \longrightarrow$

(iii) $B_2H_6 + H_2O \longrightarrow$

(iv) $B_2H_6 + NaH \longrightarrow$

(v) $B_2H_6 + Cl_2 \longrightarrow$ (5,5,5)

Q3. (a) Define the terms S, T, Y, and X in STYX code. Draw the structures of the following boranes using STYX code:

(i) B_5H_9

(ii) B_5H_{11}

(b) Calculate the number of skeletal electrons in the following boranes and carboranes:

(i) $B_6H_6^{2-}$

(ii) $C_2B_3H_9$

(iii) B_4H_{10}

(iv) $C_2B_3H_7$

(v) $B_{10}H_{14}$

(c) How does Jemmis rule differ from Wade rules? (5,5,5)

Q4. (a) What are metallic clusters? How are they classified on the basis of applications?

(b) Define Jemmis electron counting rule. Discuss the stabilities of the following clusters using Jemmis rule:

(i) $C_2B_9H_{11}^{2-}$
(ii) $(C_2B_{10}H_{11})_2$

(c) Discuss the structure of B_4H_{10}. What will be the product when it reacts with Me_3N? (5,5,5)

Q5. (a) Define closo, nido, and arachno clusters. How are they related to each other?
(b) Find the STYX numbers of the following clusters:
(i) B_6H_{12}
(ii) $B_8H_8^{2-}$
(iii) B_8H_{12}
(iv) $B_{10}H_{14}$
(v) B_7H_{11}

(c) What are heteroboranes ? Are carboranes heteroboranes? (5,,55)

Q6. Write short notes on the following:
(a) Boron Carbide
(b) Metal Borides
(c) Applications of Molecular Clusters (5,5,5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 10534 **K**

Unique Paper Code : 2173010040

Name of the Paper : DSE: Reactive Intermediates of Organic Chemistry

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

Semester : VII

Duration : 2 Hours Maximum Marks : 60

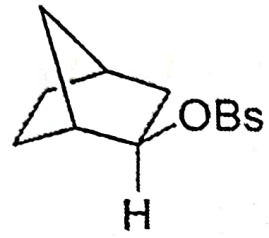
Instructions for Candidates

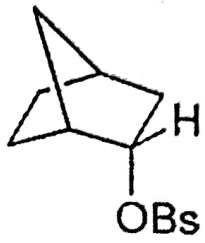
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **all** parts of a question together.
3. Attempt any **four** questions.
4. **All** questions carry equal marks.

1. (a) Differentiate between classical and non-classical carbocation with examples.

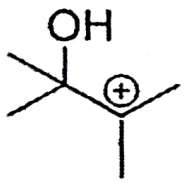
   (b) Explain why 1,2-hydride shifts are more common than 1,2-alkyl shifts in carbocation rearrangements. Support your answer with mechanistic reasoning.

(c) Acetoylsis of optically active exo-2-norbornyl brosylate (1) give racemic mixture of 2- exo acetates but no endo isomer was formed further the rate of reaction was 350 times faster than its endo isomer (2). Explain. (5,5,5)

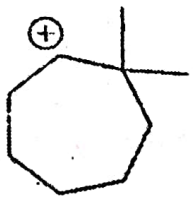
(1) 

(2) 

2. (a) Among X, Y and Z, which carbocations are likely to undergo rearrangement? Justify your answer with reasoning.



X



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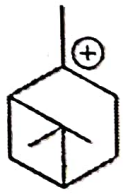
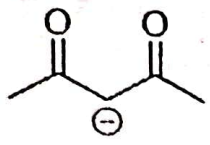


Z

(b) Discuss the factors affecting the stability of carbanions. Also, arrange the following anions in decreasing order of stability with suitable explanation.



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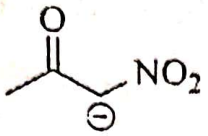

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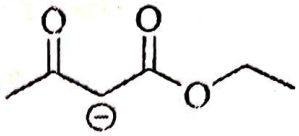


III

(c) Explain the reversibility in ambident ion reactions using example of O- vs C- alkylation of enolate ion. (5,5,5)

3. (a) To the following carbenes, assign the appropriate hybridization and multiplicity. Also, arrange them in decreasing order of stability by giving suitable explanation.

I

II

III

(b) Addition of triplet carbene ($:CH_2$) to but-2-ene is a non-stereospecific reaction. Explain.

(c) Amdt-Eistert reaction is a synthetic application of the Wolff rearrangement Explain. (5,5,5)

4. (a) Describe the structure, electronic states and methods of generating nitrenes.

(b) Explain the Schmidt rearrangement starting from a carboxylic acid.

P.T.O.

(c) Describe the preparation of phosphorus ylids and their application in organic synthesis. (5,5,5)

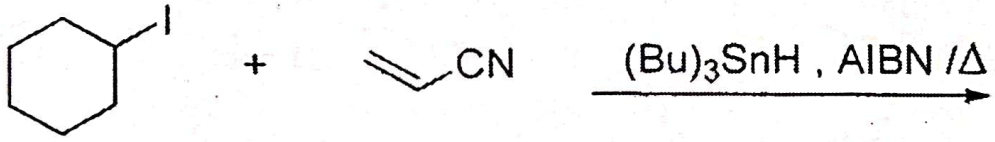
5. Write short note (including mechanism) on the followings :

(a) Barton deoxygenation reaction

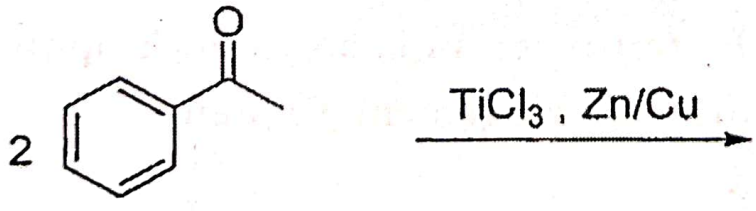
(b) Beckmann rearrangement

(c) Sulfur ylids and its applications (5,5,5)

6. (a) Complete the following reaction and give suitable mechanism showing the role of AIBN:



(b) Give the major product in the following reaction. Explain with mechanism.



(c) Describe the insertion and addition reactions of nitrenes. (5,5,5)

[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7014 **K**

Unique Paper Code : 2172511101

Name of the Paper : DSC – Basic Concepts of Organic Chemistry

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

Semester : I

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 all parts of a question together.
3. Attempt any **four** questions. **All** questions carry equal marks.

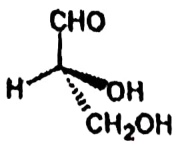
1. Write the product(s) with complete chemical reaction for any five of the following. Name the reaction and the intermediate involved.
   (a) Benzene is treated with acetyl chloride in presence of $AlCl_3$.
   (b) Phenol is treated with chloroform in presence of sodium hydroxide,
   (c) Cyclohexanone oxime is treated with concentrated sulphuric acid,
   (d) Two moles of acetaldehyde are made to react in presence of NaOH.
   (e) Prop-2-enal is treated with diethyl malonate in presence of hydroxide ion.
   (f) 2,3-Dimethylbutane-2,3-diol is treated with dilute sulphuric acid.
   (g) Propene is reacted with BH_3 followed by oxidation with H_2O_2 in presence of NaOH. (3×5)

2. Give reasons for the following : **(Any five)**
   (a) Benzyl carbocation is more stable than allyl carbocation,
   (b) Acetaldehyde reacts faster than acetone towards nucleophilic addition reaction.
   (c) pk_a of nitroacetic acid is 1.68 while pk_a of acetic acid is 4.76.
   (d) Aniline is less basic than ethylamine.
   (e) 2,3-Dimethylbut-2-ene is more stable than but-2-ene,

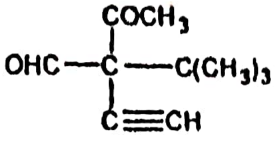
P.T.O.

(f) Aryl halides have very low reactivity towards nucleophilic substitution reaction as compared to alkyl halides. (3×5)

3. (a) Assign E/Z or R/S to the following :



(I)



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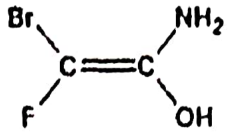
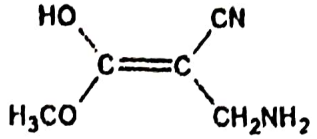


(III)



(IV)

(b) Draw the various conformations of n-butane and arrange them in increasing order of their stability. Give reasons for the stability order.

(c) Why S_N^1 reactions are accompanied by racemization? (2×4,4,3)

4. (a) Distinguish between :
   (i) E_1 and E_2 reaction
   (ii) Racemic mixture and meso-Compound

(b) Write the product(s) and mechanism involved when prop-1-ene reacts with HBr in i) presence and ii) absence of peroxide.

(c) Write products of the following reactions and state the type of the reaction involved :
   (i) Propyne is treated with dilute sulphuric acid in presence of mercuric sulphate.
   (ii) 2-Chlorobutane is treated with aqueous sodium hydroxide. (5×3)

5. (a) Explain why halogens in haloarenes are weakly deactivating and ortho/para directing.

(b) Explain the formation of different products formed when ethyl bromide is treated with NaCN and AgCN.

(c) What happens when chlorobenzene is treated with $NaNH_2$ in liquid NH_3? Give the mechanism involved. (5×3)

6. Write short notes (with mechanistic details) of any **three** of the following :
   (a) Perkin Reaction
   (b) Wagner – Meerwein rearrangement
   (c) Claisen-Schimdt reaction
   (d) Benzoin Condensation (5×3)

(1000)

(17)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7007 **K**

Unique Paper Code : 2172512302

Name of the Paper : DSC: Chemical Energetics and Equilibria

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

Semester : III

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.

P.T.O.

Values of constant :

$R = 8.314\ J\ K^{-1}\ mol^{-1}$ or $1.987\ cal\ K^{-1}\ mol^{-1}$ or $0.082\ atm\ dm^3 K^{-1}\ mol^{-1}$

$K_b = 1.380649 \times 10^{-23}\ J\ K^{-1}$

$F = 96500\ C\ mol^{-1}$

$N_A = 6.022 \times 10^{23}\ mol^{-1}$

1. Answer **any five** questions. Each question carries equal marks

(a) What are extensive variables? Identify the extensive variables among the following.
specific heat capacity, molar volume, enthalpy, chemical potential, free energy.

(b) The Joule coefficient of an ideal gas is zero. Explain.

(c) The enthalpy of neutralization of strong acid with strong base is constant. Give reason.

(d) At constant temperature and pressure, Gibbs free energy attains a minimum value at equilibrium ($dG_{T,p} = 0$). Justify this statement.

(e) What are buffer solutions? Give one example of acidic buffer and basic buffer.

(f) Draw the pH metric titration curve of strong acid vs strong base. What is the pH at equivalence point? (3×5)

2. (a) Applying the first law of thermodynamics, prove that heat is an inexact differential.

(b) Describe the Joule's experiment. Write the mathematical expression that the energy of a gas is a function of temperature only.

(c) 7.0 g of N2 at 25°C is subjected to reversible isothermal expansion from initial pressure of 0.505 MPa to final pressure of 0.202 MPa. Calculate q, w, ΔU and ΔH. (5×3)

3. (a) State Hess's law of constant heat summation. Describe the Born Haber Cycle for the determination of lattice energy of NaCl.

(b) Define integral enthalpy of solution. Enthalpy of neutralization of HCl by NaOH is -57.32 kJ mol^{-1} and by NH_4OH is -51.34 kJ mol^{-1}. Calculate enthalpy of dissociation of NH_4OH.

(c) On the basis of following data, evaluate the standard enthalpy of formation of tungsten carbide (WC).

(i) $W(s) + 3/2O_2(g) \rightarrow WO_3(s)$

$\Delta_r H_{298k} = -837.47 \text{ kJ mol}^{-1}$

(ii) $WC(s) + 5/2O_2(g) \rightarrow WO_3(s) + CO_2(g)$

$\Delta_r H_{298k} = -1195.79 \text{ kJ mol}^{-1}$

(iii) $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$

$\Delta_r H_{298k} = -393.51 \text{ kJ mol}^{-1}$

(5×3)

4. (a) Define heat capacity. Prove that for an ideal gas

$C_{p,m} - C_{vm} = R$ (for 1 mole of an ideal gas)

(b) Derive the expression for change in entropy function when the amount n mole of an ideal gas undergoes change from temperature T_1 and volume V_1 to temperature T_2 to volume V_2.

(c) Prove that the change in Gibbs free energy at constant temperature and pressure is equal to the net amount of non-mechanical work done.

(5×3)

5. (a) Derive the expression of equilibrium constant of a weak electrolyte AB in terms of degree of dissociation a and concentration c. Also prove that $\alpha \rightarrow 1$ as $c \rightarrow 0$.

(b) The pH of pure water at 40°C is found to be 6.765. What is the value of pK_w? What will be the nature of the solution at 40°C having $[H^+] = 0.54 \times 10^{-7}M$. What will be the pOH of the solution.

(c) A buffer is made by adding 25.0 cm^3 of 0.1M Sodium acetate to 50.0 cm^3 of 0.1M acetic acid ($pK_a = 4.75$). Write the Henderson-Hasselbalch equation and determine pH of the solution. What would be the pH if this buffer is added to:

(i) 25.0 cm^3 of distilled water

(ii) 10.0 cm^3 of 0.1M HCl (5×3)

6. (a) Define solubility product of sparingly soluble salt. What is the solubility of $Ag_2(CrO_4)$ in water if the value of solubility product is $K_s = 1.3 \times 10^{-11}\ M^3$.

(b) At 1105 K, the value of $K°_p$ for a reaction $SO_2(g) + ½\ O_2 \leftrightarrow SO_3(g)$ is 0.63. Calculate

(i) the standard free energy change for this reaction at 1105K

(ii) the free energy change at 1105 K for the reaction

$SO_2(1\ bar) + ½\ O_2(25\ bar) \leftrightarrow SO_3(2\ bar)$

(c) Write short notes on any **two** :

(i) Common ion effect

(ii) Residual entropy

(iii) Le Chatelier's principle (5,5,2.5×2)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7122 **K**

Unique Paper Code : 2173522006

Name of the Paper : DSE: Biomolecules I

Name of the Course : **B.Sc. (Prog.) Life Sciences / B.Sc. (Prog.) Physical Sciences / B.Sc. (Prog.) Industrial Chemistry**

Semester : V/III

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 in all.

1. Give reason (any 5) :

   (a) Fructose is a ketose sugar yet it gives positive Tollen's and Fehling's test.

   (b) Fats having low molecular weight fatty acids, have high Saponification number.

(c) Glucose and fructose form same osazone.

(d) DNA Replication is a semiconservative process.

(e) Fats and oils with high Iodine number are more prone to rancidity.

(f) DNA is more stable than RNA. (3×5)

2. (a) Define Iodine Number stating its significance. Write structure of Glyceryl trioleate and determine its Iodine number.

(b) Explain Rancidity of fats and oils explaining its different types. How it can be prevented?

(c) What are phospholipids? Give their structures, classification and biological significance. (5,5,5)

3. Write short notes on : **(any 3)**

(a) Liposomes and their biological importance.

(b) Genetic code and its characteristics.

(c) Amadori rearrangement and its significance.

(d) Invert sugar, its systematic name and its structure. (5,5,5)

4. (a) What are different types of RNA and their biological functions? Write structure of a segment of RNA molecule containing following base sequence- cytosine, uracil, guanine.

(b) Describe various steps involved in the process of DNA replication.

(c) Explain Watson and Crick model of DNA. What are the forces responsible to stabilize this structure? (5,5,5)

5. (a) What is Mutarotation? Taking glucose as a reference compound explain this phenomenon. Which carbohydrate do not show mutarotation and why?

(b) Convert D-arabinose to D-glucose and vice versa. What are these reactions known as?

(c) Write various reactions in support of the open chain structure of glucose. (5,5,5)

6. Differentiate between following : (any 5)

(a) Anomers and Epimers (give one example of each)

(b) DNA and RNA

(c) Essential and non-essential fatty acids (give one example of each)

(d) Phospholipids and glycolipids (give one example of each)

(e) Structures of starch and cellulose

(f) Transcription and translation (3×5)