

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1038

**D**

Unique Paper Code : 2172011102

Name of the Paper : DSC 2-Basic Concepts and  
Aliphatic Hydrocarbons  
(Organic Chemistry-1)

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

Semester : I

Duration : 3 Hours

Maximum Marks : 90

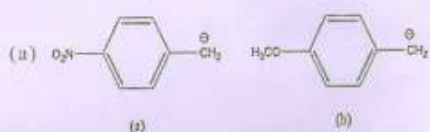
**Instructions for Candidates**

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **SIX** questions.
3. All questions carry **15** marks.
4. This paper contains **8** questions.

1. (i) Acid catalysed dehydration of Neopentyl alcohol gives two alkenes A and B as major and minor product(s). Identify the two alkenes A and B and explain the mechanism involved.

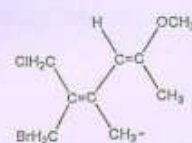
P.T.O.

(ii) Out of following, which is more stable and why?



(iii) Define the terms racemic mixture and resolution of racemic mixture. Illustrate the chemical method for the resolution of a racemic mixture with an example. (5,5,5)

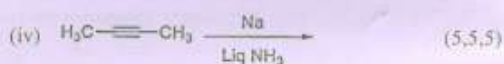
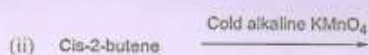
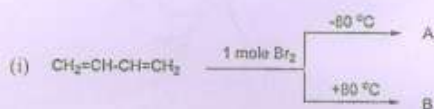
2. (i) Write down the Fischer Projection of all the possible stereoisomers of 2,3-Dibromo pentane. Designate erythro and threo nomenclature to all the stereoisomers and assign absolute configuration (R/S) at each chiral centre.
- (ii) (a) Give name and structure of one meso compound. Meso compounds are optically active or inactive? Give reason in support of your answer.
- (b) Indicate whether each of the following compound is E or Z



(iii) Give the Structure and hybridisation of Carbocation and Carbenes. (5,5,5)

3. (i) Draw all the conformations of cyclohexane and arrange them in order of increasing stability. Give reasons for stability order.
- (ii) (a) "Staggered conformation of n-butane is more stable than Eclipsed". Explain with suitable example.
- (b) Define plane polarised light and specific rotation.
- (iii) Differentiate between enantiomers and diastereomers with example. Among these two, which can be easily separated and why? (5,5,5)

4. Write the products with mechanism and appropriate stereochemistry wherever applicable: (Attempt any three)



5. (i) Chlorine is more reactive while bromine is more selective in its reaction with Propane. Explain.  
 (ii) Calculate the percentage of isomers formed during the monobromination of 2,3-dimethylbutane. The relative reactivity for 1°, 2°, 3° hydrogens are 1, 82 and 1600, respectively.

- (iii) Compare the reactivity of alkene and alkynes towards electrophilic addition reactions. (5,5,5)

6. Give reasons:

- (i) Propene reacts with HBr in presence of peroxide to give 1-bromopropane whereas in absence of peroxide it gives 2-bromopropane.  
 (ii) Electromeric effect is temporary effect while Inductive effect is permanent effect.  
 (iii) Bromination of trans-2-butene gives meso-dibromo product while bromination of cis-2-butene gives racemic mixture? (5,5,5)
7. (i) Arrange the following in increasing order of acidity with giving suitable reasons-
- (a) Acetic acid, 1-chloro acetic acid and Propanoic acid.  
 (b) Phenol, Ethanol, Acetic acid
- (ii) Define hyperconjugation. Explain on the basis of hyperconjugation, why 2,3-dimethyl but-2-ene is more stable than 2-methyl but-1-ene.

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(iii) Vinyl chloride is less reactive than Allyl chloride towards nucleophilic substitution reactions. (5,5,5)

8. Write short on the followings (any three)

(i) Wurtz reaction (with mechanism and limitations)

(ii) Saytzeff Vs Hofmann elimination

(iii) Baeyer's Strain Theory

(iv) Diels-Alder reaction

(5×3=15)

(500)

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1889 **C**

Unique Paper Code : 32175901

Name of the Paper : Atomic Structure, Bonding,  
General Organic Chemistry  
and Aliphatic Hydrocarbons

Name of the Course : **Generic Elective: Chemistry**

Semester : I / III / 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. Use separate answer sheets for **Section A** and **Section B**.
3. Answer **three** questions from each section (**Section A** and **Section B**).

**SECTION - A**

*Attempt three questions from Section-A.*

*Question no. 1 is compulsory.*

P.T.O.

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1. Answer the following briefly
- Write physical significance of  $\psi$  and  $\psi^2$ .
  - Which is more covalent LiI or CsI and why?
  - CuCl is insoluble in water while NaCl is soluble. Why?
  - Why  $\text{BeCl}_2$  has zero dipole moment while  $\text{H}_2\text{S}$  has some value?
  - Plot the radial distribution curves for 1s and 2p orbital.
  - Write the electronic configuration of Cr and Cu.  
(2,2,5,2,5,2,5,2,2)
2. (a) Calculate the uncertainty in the position of a particle whose uncertainty in momentum is  $3.3 \times 10^{-2} \text{Kg m s}^{-1}$  ( $h = 6.62 \times 10^{-34} \text{ J s}$ ).
- Draw the resonating structures of  $\text{SO}_3$  and  $\text{CO}_2$ .
  - Write the fundamental rules of VSEPR theory.  
(4,4,4)
3. (a) Draw the MO diagram for CO molecule. Explain.

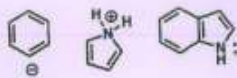
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- Write the time independent Schrodinger's wave equation in three-dimensional motion and explain the terms involved.
  - Give the hybridization of the central atom and shape of the following molecules:  
 $\text{CO}_3^{2-}$ ,  $\text{CH}_4$ ,  $\text{PCl}_5$ ,  $\text{SnCl}_2$  (4,4,4)
4. Write short notes on any three :
- Exchange energy
  - Fajan's rule
  - Lattice energy
  - Resonance (4,4,4)
- SECTION - B**  
(Attempt any three questions)
5. (a) Starting from 1-bromobutane, list three methods for the preparation of butane. (4,5)

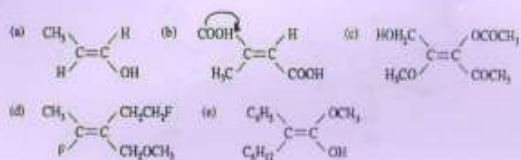
P.T.O.

- (b) Explain the acidic nature of acetylenic hydrogen. Compare its acidic strength with ethene and ethane. (4)
- (c) Give differences between enantiomers and diastereomers with suitable examples. (4)
6. (a) Describe homolytic and heterolytic fission of covalent bonds. How do these lead to the formation of carbocation and carbanions? (4.5)
- (b) What happens when :
- But-2-yne is treated with hydrogen in presence of Lindlar's catalyst.
  - But-2-yne is treated with sodium in liquid ammonia (4)
- (c) Define Huckel's-rule of aromaticity. Which of the following are aromatic, anti-aromatic and non-aromatic?



(4)

7. (a) Designate 'E' & 'Z' to the following double bonded compounds : (4.5)

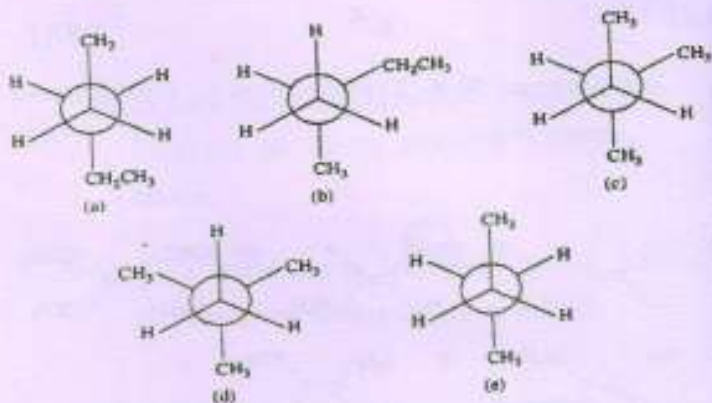


- (b) Carry out the following conversions : (2×4=8)

- Ethane to Butane
- Propane to 2,3-Dimethylbutane
- Butyne to *trans*-2-butene
- Propene to acetic acid

8. (a) Which of the following does not represent a conformer of  $C_2H_5$ ? Identify the molecules and indicate the carbon-carbon bond around which free rotation occurs as depicted by following Newman projections? (4.5)

P.T.O.



(b) Explain one method involved in the synthesis of terminal and non-terminal acetylenes. (4)

(c) Write short notes on (any two): (2×2)

- (i) Kolbe's electrolysis
- (ii) Wolf Kishner reduction
- (iii) Wurtz-fittig reaction



[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1750

C

Unique Paper Code : 32175901

Name of the Paper : Atomic Structure, Bonding,  
General Organic Chemistry  
and Aliphatic Hydrocarbons

Name of the Course : Generic Elective: Chemistry

Semester : I / III / 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. Use separate answer sheets for Section A and Section B.
3. Answer three questions from each section (Section A and Section B).

**SECTION - A**

*Attempt three questions from Section-A.  
Question no. 1 is compulsory.*

P.T.O.

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1. Answer the following briefly:
- Which is more covalent  $\text{FeCl}_2$  or  $\text{FeCl}_3$  and why?
  - Why  $\text{BaSO}_4$  is insoluble in water?
  - Why bond angle of  $\text{CH}_4$  is greater than  $\text{NH}_3$ ?
  - Plot the radial distribution curves for 3s and 3p orbital.
  - Is orbital is spherically symmetrical. Explain.  
(3,2,3,3,2.5)
2. (a) Describe the Born Haber cycle for calculating lattice energy in the formation of  $\text{NaCl}(s)$ .
- (b) Draw the resonating structures of  $\text{CO}_3^{2-}$  and  $\text{O}_3$ .
- (c) Calculate the wavelength associated with a body of mass 5mg moving with a velocity of  $2\text{ms}^{-1}$ .  
(4,4,4)
3. (a) Differentiate between :
- Valence bond theory and Molecular orbital theory
  - Bonding and antibonding molecular orbital

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- Plot radial probability distribution curves for 4s, 4p, 4d and 4f orbitals.
  - Give the hybridization of the central atom and shape of the following molecules :  
 $\text{SO}_4^{2-}$ ,  $\text{SF}_6$ ,  $\text{H}_2\text{O}$ ,  $\text{XeF}_4$  (4,4,4)
4. (a) Explain the diamagnetic behavior of  $\text{N}_2$  molecule with the help of M.O. diagram.
- (b)  $\text{BeF}_2$  is linear while  $\text{SF}_2$  is angular. Explain.
- (c) Write short notes on any two :
- Hund's rule
  - Pauli's exclusion principle (4,4,4)

## SECTION - B

(Attempt any three questions.)

5. (a) Give the product obtained by the reaction of dil.  $\text{H}_2\text{SO}_4/\text{HgSO}_4$  with
- Acetylene and

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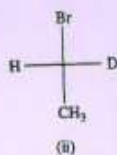
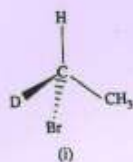
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(ii) But-2-yne.

Also give the mechanism of reaction with any one of them. (4.5)

- (b) The peroxide effect (anti-Markovnikov's rule) in alkenes is observed only in the addition of HBr and not HCl or HI. Explain why? (4)
- (c) What does conformation mean? Draw chair and boat conformations of cyclohexane. Which is more stable and why? (4)
6. (a) Indicate whether the following two structures are identical or related to each other as enantiomers? Can the stereoisomers of a molecule with one chiral centre (stereogenic centre) be related as diastereomers?



(3.5)

- (b) Explain any **three** of the following: (3×3)

(i) Ozonolysis of alkenes

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(ii) Hydroxylation reactions

(iii) Hydroboration

(iv) Alkylation of alkenes

7. (a) Two isomeric compounds A and B on reduction with Zn-Cu couple yield n-butane. Another compound C, sodium salt of a carboxylic acid, on electrolysis also yields n-butane. Isomers A and B undergo Wurtz reaction to yield n-octane and 3,4-dimethylhexane respectively. However, C on fusion with soda-lime yields ethane. Identify A, B, and C and write the reactions involved. (4.5)
- (b) What products will be obtained from cyclopropene and cyclobutene on
- (i) Catalytic hydrogenation
- (ii) Reaction with HBr (4)
- (c) Explain oxymercuration and demercuration for formation of alcohol. (4)
8. (a) Define
- (i) Inductive Effect

P.T.O.

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(ii) Electromeric Effect

Give examples to illustrate these. (4.5)

(b) Write short notes on (any three) (3×3)

(i) Corey-House synthesis

(ii) Anti-markovnikov rule

(iii) Hyperconjugation

(iv) Saytzeff rule

(v) Grignard Reagent

(500)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1550

C

Unique Paper Code : 42171103

Name of the Paper : Atomic Structure, Chemical  
Bonding, General Organic  
Chemistry & Aliphatic  
Hydrocarbons

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

Semester : I

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 answer booklet for each section.
3. Attempt all parts of a question together.
4. Use of calculator is allowed.

**SECTION A**

*(Attempt any **THREE** questions from Section A)*

P.T.O.

1. (a) Write the time independent Schrodinger wave equation for hydrogen atom and define the terms involved in it.
  - (b) Melting points of NaCl and CuCl are 442°C and 800°C respectively. Justify.
  - (c) Predict the hybridization of  $\text{NH}_3$ ,  $\text{SO}_4^{2-}$ ,  $\text{XeF}_2$ .
  - (d) Draw the molecular orbital diagram for  $\text{O}_2$  molecule. Predict its magnetic character.  
(3,3,3,3.5)
2. (a) Write the Born-Lande expression for Lattice energy and define the terms involved in it.
  - (b) Bond angle in  $\text{CH}_4$  is 109.5° whereas in  $\text{NH}_3$  the bond angle is 107.5°. Explain.
  - (c) Draw the radial probability distribution plots for 2s, 2p and 3p orbitals.
  - (d) Arrange the following in terms of increasing order of their lattice energy and Explain the order. LiF,  $\text{CaF}_2$ , MgS.  
(3,3,3,3.5)

3. (a) Arrange  $\text{O}_2$ ,  $\text{O}_2^+$ ,  $\text{O}_2^-$ ,  $\text{O}_2^{2-}$  in the increasing order of their bond length.
- (b) Arrange the following in the increasing order of their melting point and explain the order.  
 $\text{CaF}_2$ ,  $\text{CaCl}_2$ ,  $\text{CaBr}_2$  and  $\text{CaI}_2$
- (c) Calculate the wavelength of a line in the Balmer series of the hydrogen spectra that corresponds to an electronic transition from 4<sup>th</sup> orbit.  $R = 109679 \text{ cm}^{-1}$ .
- (d) Calculate the lattice energy of KCl using Bom-Haber Cycle  
Sublimation energy of  $\text{K}(s) = 89 \text{ KJmol}^{-1}$ , Ionization energy of  $\text{K}(g) = 425 \text{ KJmol}^{-1}$ , Dissociation energy of  $\text{Cl}_2(g) = 244 \text{ KJmol}^{-1}$ , Electron gain enthalpy for  $\text{Cl}(g) = -355 \text{ KJmol}^{-1}$  and heat of formation of  $\text{KCl}(s) = -438 \text{ KJmol}^{-1}$ .  
(3,3,3,3.5)

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4. (a) Calculate the % ionic character in the HX molecule, if the dipole moment is 1.92D, bond length is  $1.2\text{\AA}$  and charge on H is  $4.8 \times 10^{-10}$  esu.
- (b) Draw the resonating structures of  $\text{CO}_3^{2-}$  and  $\text{N}_3^-$ .
- (c) Write the complete electronic configuration of two transition metals exhibiting anomalous pattern.
- (d) Write a short note on Fajan's rule. (3,3,3,5)

## SECTION B

## ORGANIC CHEMISTRY

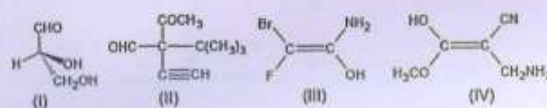
(Attempt any TWO questions from Section B)

1. (a) Give reasons for the following :
- (i) Cyclopentadienyl anion is aromatic while cyclopentadiene is not.
- (ii)  $pK_a$  of nitroacetic acid is 1.68 while  $pK_a$  of acetic acid is 4.76.

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- (iii) Benzyl carbocation is more stable than Isopropyl carbocation.
- (iv) Trans alkenes have lower boiling point than cis alkenes.
- (v) Racemic Mixture is optically inactive. (1½×5=7½)
- (b) Assign R/S or E/Z to the following compounds



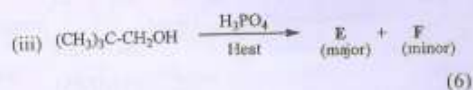
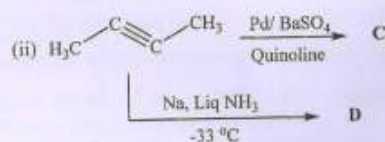
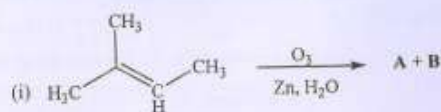
(2×4=8)

- (c) Carry out the following conversions :

- (i) Propane to 2,3-Dimethyl butane
- (ii) Propyne to Pent-2-yne (3)

P.T.O.

2. (a) Write the products of the following reactions :



(b) How many optical isomers are possible for 2,3-Dichloropentane? Draw their Fischer projections and give the relationship between them. (6)

(c) What happens when propane is subjected to chlorine gas in presence of light? Predict the product(s) and give the mechanism involved. (4)

(d) Explain why addition of HBr to propene in presence and absence of peroxide give different products. (3)

3. (a) Arrange the following in the order mentioned in parentheses with suitable reasons :

(i)  $\text{CH}_3^-$ ,  $(\text{CH}_3)_2\text{CH}^-$ ,  $(\text{CH}_3)_3\text{C}^-$  (decreasing order of stability)

(ii)  $\text{HCOOH}$ ,  $\text{CH}_3\text{COOH}$ ,  $\text{CH}_3\text{CH}_2\text{COOH}$  (decreasing order of acid strength) (4)

(b) Why terminal alkynes are acidic in nature in comparison to alkanes and alkenes? How will you chemically distinguish a terminal and non-terminal alkyne? (3)

(c) What happens when 3-Methylbutene is subjected to hydroboration oxidation? Give the steps involved and name of the product formed? (2½)

(d) Write short notes on any **three** of the following :

(i) Mesomeric Effect and its Applications



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- (ii) Conformations of n-Butane
- (iii) Oxymercuration Demercuration Reaction
- (iv) E1 and E2 Reactions (3×3=9)

(200)

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1019 **D**

Unique Paper Code : 2172011101

Name of the Paper : DSC-1, Atomic Structure &  
Chemical Bonding

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

Semester : 1

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.
3. Question no. **1** is compulsory.
4. All questions carry equal marks.

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

(i) NaCl is more ionic than CuCl.

(ii)  $\text{NF}_3$  has lower dipole moment than  $\text{NH}_3$ .

P.T.O.

- (iii) MgO has higher lattice energy than NaCl.
- (iv) First ionization energy of Al is less than Mg, but reverse is true for second ionization energy of Al.
- (v)  $H_2$  is known but  $He_2$  is not.
- (vi) H-N-H Bond angles are higher in  $NH_3$  than H-P-H in  $PH_3$ . (5×3)
2. (i) Calculate the heat of formation of CsF from its elements from the following data using Born-Haber cycle.
- Electron gain enthalpy of F =  $-328 \text{ kJ mol}^{-1}$   
 Ionisation enthalpy of Cs =  $+357.7 \text{ kJ mol}^{-1}$   
 Heat of sublimation of Cs =  $+76.1 \text{ kJ mol}^{-1}$   
 Bond dissociation energy of  $F_2 = \text{kJ mol}^{-1}$   
 Lattice enthalpy of CsF =  $+740 \text{ kJ mol}^{-1}$
- (ii) Write Schrodinger wave equation for hydrogen atom. Is Schrodinger wave equation an eigen value equation? Justify giving reasons.

- (iii) Using VSEPR theory give the shapes of the following molecules:  
 $XeOF_2$ ,  $BrF_4^-$ ,  $PCl_6^-$ ,  $PO_4^{3-}$  and  $SF_4$  (3×5)
3. (i) Derive the Born Lande's equation for lattice energy of a crystal lattice.
- (ii) Draw a molecular energy level diagrams for  $C_2$  and  $C_2^-$  and compare their stabilities and magnetic behaviour.
- (iii) Write the  $\psi(\phi)$  equation of the hydrogen atom and normalize the equation to obtain the solution. (3×5)
4. (i) Describe Bent's rule and explain the structure of  $PCl_3F_2$ .
- (ii) Explain why s-orbitals are spherical in shape? How many radial and angular nodes are present in 2p and 3d orbitals? Specify their location.
- (iii) Draw neatly labelled diagrams for radial probability distribution curves for 2s, 3s, 3p, 3d and 4s orbitals? (3×5)

5. (i) The dipole moment of HI is 0.384 D and bond distance is 1.60 Å. What will be the percent of ionic character in HI?
- (ii) Calculate the radius ratio for an ionic crystal when the coordination number of cation is  
a. 4 (Square Planar), and b. 6 (Octahedral)
- (iii) Which of the two molecules,  $N_2$  and NO has higher ionization energy? Give reasons. Support your answer with their MO diagram. (3×5)
6. (i) Calculate the effective nuclear charge for 3d and 4s electrons in Cobalt ( $Z=27$ ) using Slater's rules.
- (ii) Give reasons (2,1.5,1.5):
- The half-filled and fully filled orbitals are associated with extra stability
  - $PCl_3$  is polar but  $BCl_3$  is non-polar.
  - Electron gain enthalpy of F is less than that of Cl.

- (iii) Write short notes on (1.5,2,1.5):
- Limitations of Slater's rule
  - Radius ratio rules
  - Applications of Fajan's rules. (3×5)
7. (i) What is the relation between polar co-ordinates and cartesian co-ordinates? On what factors the radial part of a wave function  $R(r)$  depends on?
- (ii) What is de-Broglie equation. How does this equation prove one of the Bohr's postulates?
- (iii) Draw Molecular Orbital diagram of CO molecule (using s-p mixing). Indicate HOMO and LUMO in it. (3×5)
8. (i) Calculate de Broglie wavelength of an electron travelling with  $1/3^{rd}$  the speed of light ( $m = 9.1 \times 10^{-31}$  kg,  $h = 6.634 \times 10^{-34}$  Js,  $c = 3.0 \times 10^8$  m s<sup>-1</sup>).
- (ii) Explain the following:
- Carbonate ion ( $CO_3^{2-}$ ) is planar anion while sulphate ( $SO_4^{2-}$ ) is not.

(b) The electronic structure of carbonate ion cannot be described by a single Lewis structure.

(iii) Comment upon the trends in bond angle variations in the following :

(a)  $\text{OF}_2$  and  $\text{H}_2\text{O}$

(b)  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{Se}$  and  $\text{H}_2\text{Te}$  (3×5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1231 **D**

Unique Paper Code : 2174001001

Name of the Paper : GE1 : Atomic Structure and  
Chemical Bonding

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

Semester : 1

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 carry equal marks.
  3. Attempt any **FOUR** questions in all.
  4. Use of scientific calculator is allowed.
- 
1. (a) Write any four postulates of molecular orbital theory.  
(b) Draw radial probability distribution curves for 3s, 3p and 3d orbitals on the same scale.

P.T.O.

- (c) In  $\text{BF}_3$  and  $\text{NH}_3$  which molecule will have zero value of dipole moment. Explain.
- (d) Give the possible value of quantum numbers for an electron in 3d and 5p orbitals. (4,4,4,3)
2. (a) What are the boundary conditions to be fulfilled by the acceptable solution of the Schrodinger wave equation?
- (b) Arrange  $\text{CH}_4$ ,  $\text{NH}_3$  and  $\text{H}_2\text{O}$  in terms of increasing order of their bond angle. Explain the order.
- (c) Write the equation for theoretical calculation of lattice energy of an ionic crystal. Explain the terms involved in it.
- (d) Draw the Molecular Orbital diagram of  $\text{B}_2^+$  ion and compare its bond order with that of  $\text{B}_2$  molecule. (4,4,4,3)
3. (a) Give the hybridization and shape of the given molecules  
 $\text{BF}_3$ ,  $\text{PF}_5$ ,  $\text{SF}_6$ ,  $\text{IF}_7$
- (b) Arrange the following in terms of increasing order of their melting points and explain the order  $\text{BeCl}_2$ ,  $\text{MgCl}_2$ ,  $\text{CaCl}_2$ ,  $\text{SrCl}_2$  and  $\text{BaCl}_2$ .
- (c) The  $\text{O}_2$  molecule is paramagnetic. Explain it on the basis of molecular orbital diagram.

- (d) Calculate the % ionic character in HF molecule if the observed dipole moment is  $6.6 \times 10^{-30}$  Cm, bond length is 91.7 pm and charge on H atom is  $1.602 \times 10^{-19}$ C. (4,4,4,3)
4. (a) Melting points of  $\text{CuCl}$  and  $\text{NaCl}$  are  $442^\circ\text{C}$  and  $800^\circ\text{C}$  respectively. Justify.
- (b) Write time independent Schrodinger wave equation for an atom and explain the terms involved in it.
- (c) Draw Born Haber cycle and Calculate heat of formation of KF molecule from the following data:
- (A) Heat of sublimation of potassium = 87.8 KJ/mol
- (B) Dissociation energy of fluorine = 158.9 KJ/mol
- (C) Ionization energy of potassium = 414.2 KJ/mol
- (D) Electron affinity of fluorine = -334.7 KJ/mol
- (E) Lattice Energy of Potassium fluoride (KF) = -807.5 KJ/mol
- (d) If the uncertainty in the position of an electron is  $4\text{\AA}$ , what will be the uncertainty in its velocity? (4,4,4,3)

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5. (a) Give the number of radial nodes and nodal planes for the following orbitals

4s, 3d, 5p, 2p

(b) Which of the following has more covalent character and why?

(i) NaCl and CuCl

(ii) AgCl and AgI

(c) Draw the resonating structures of carbonate ion and acetate ion.

(d) Draw the shape of d-orbitals. (4,4,4,3)

6. (a) Write the electronic configuration of elements with atomic number: 18, 24, 29, 46

(b) Which among the following will have higher melting point:

(i) SnO or LiCl, (ii) BaO or NaCl

(c) Arrange the following in terms of increasing order of their thermal stability.

$\text{BeCO}_3$ ,  $\text{MgCO}_3$ ,  $\text{CaCO}_3$ ,  $\text{SrCO}_3$ , and  $\text{BaCO}_3$

(d) Comment on the shape and dipole moment of  $\text{CCl}_4$  and  $\text{CHCl}_3$ . (4,4,4,3)

(2000)



[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1057 **D**

Unique Paper Code : 2172011103

Name of the Paper : DSC 3: Gaseous and Liquid  
State (Physical Chemistry-I)

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

Semester : 1

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.

P.T.O.

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4. Use of Scientific Calculator is permitted.

$$(R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} \quad k = 1.38 \times 10^{-23} \text{ JK}^{-1})$$

$$(N_A = 6.023 \times 10^{23} \text{ mol}^{-1})$$

1. Answer any 5 of the following:

(a) The viscosity of liquids decreases while that of gases increases with rise in temperature. Explain.

(3)

(b) Explain the effect of temperature and pressure on collision number of a gas.

(3)

(c) Roughly sketch the Maxwell distribution curve for the gas molecules in terms of molecular velocities. Label both axes and explain the effect of temperature on the distribution curve.

(3)

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(d) The composition of gases in the earth's atmosphere varies with height. Explain.

(3)

(e) Discuss the effect of detergent concentration on the surface tension of water giving graphical representation. Why surface tension becomes nearly constant at higher concentrations of detergent?

(3)

(f) Explain the dependence of surface tension on temperature and why the surface tension of a liquid becomes zero at its critical temperature.

(3)

2. (a) Describe the reasons for deviation of gases from ideal behaviour. Derive van der Waals equation of state for a real gas.

(5)

P.T.O.

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(b) The coefficient of viscosity of  $\text{CO}_2$  gas is  $148 \mu\text{P}$  at  $20^\circ\text{C}$ . Calculate its collision diameter and mean free path. (5)

(c) Draw labelled diagram of P-V isotherms of  $\text{CO}_2$ . Explain these isotherms and continuity of states. (5)

3. (a) Using the van der Waals equation of state, derive the following universal relation:

$$P_r = \frac{8T_r}{3V_r - 1} - \frac{3}{V_r} \quad (5)$$

(b) Calculate the fraction of methane gas molecules at  $27^\circ\text{C}$  and 1 atm possessing velocities between  $450 \pm 10 \text{ m/s}$ . (5)

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5

(c) Derive an expression for the coefficient of viscosity of a gas,  $\eta$  in terms of the mean free path,  $\lambda$  and show that  $\eta$  of a gas is dependent on temperature, but is independent of pressure. (5)

4. (a) Derive the expression:  $P = P_0 \exp(-Mgh/RT)$ . Explain the effect of temperature of the gas on the variation of pressure with height in the light of this equation. (5)

(b) Determine the molar mass of a gas if its pressure falls to one-third of its value in a vertical distance of 4 meters at  $27^\circ\text{C}$ . (5)

(c) The values of critical constants of a gas are:  $P_c = 45.6 \text{ atm}$ ,  $V_c = 0.0987 \text{ dm}^3 \text{ mol}^{-1}$  and  $T_c = 190.6 \text{ K}$ . Calculate the van der Waals constants and critical compressibility factor. (5)

5. (a) What do you mean by vapour pressure of a liquid?

Explain the effect of temperature on vapour pressure of liquid giving expressions. (5)

- (b) The enthalpy of vaporization of cyclohexane at its boiling point  $127\text{ }^\circ\text{C}$  is  $400\text{ J/g}$ . If it is to be distilled at  $26\text{ }^\circ\text{C}$  to what value must the pressure be reduced? (5)

- (c) Calculate the surface tension of liquid benzene and the radius of the capillary tube, if the level of water and benzene rose in the capillary is  $9.9\text{ cm}$  and  $4.3\text{ cm}$ , respectively. Given surface tension of water at  $20\text{ }^\circ\text{C} = 72.75\text{ dyne cm}^{-1}$ , density of water =  $998.2\text{ kg m}^{-3}$  and density of benzene =  $900\text{ kg m}^{-3}$ . (5)

6. (a) Describing the origin of viscosity in liquids, define coefficient of viscosity. Write units of viscosity.

Derive the expression for determination of viscosity of a liquid by using Ostwald's viscometer method. (5)

- (b) The viscosity of a liquid is  $6 \times 10^{-4}\text{ N s m}^{-2}$  at  $27\text{ }^\circ\text{C}$  and  $3 \times 10^{-4}\text{ N s m}^{-2}$  at  $327\text{ }^\circ\text{C}$ . Calculate the energy of activation of viscous flow assuming it to be constant over this temperature range. (5)

- (c) (i) The viscosity of glycerol is very high as compared to that of water. Explain. (2)

- (ii) Comment on the effect of addition of sucrose on the viscosity of water? (2)

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(iii) Is it possible to liquefy an ideal gas? Explain.

(1)

(2000)

Dec-2022

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1001

D

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

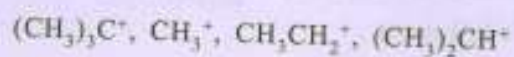
Maximum Marks : 60

**Instructions for Candidates**

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

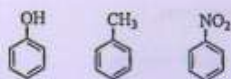
1. Answer the following : (any five)

(a) Arrange the following in decreasing order of their stability and give reasons



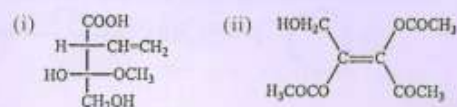
P.T.O.

- (b) Why is the reaction of carbonyl compound with 2,4-dinitrophenylhydrazine carried out in weakly acidic medium?
- (c) What is an ambident ion? How can you prepare Nitrite and Nitro from a given alkyl halide?
- (d) Why benzylamine is more basic than aniline?
- (e) Differentiate between D/L and d/l notations.
- (f) Explain, formic acid is stronger acid than acetic acid.
- (g) Giving reasons, arrange the following in increasing order of reactivity towards ring bromination:

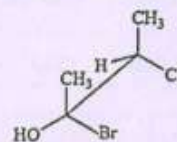


(3,3,3,3,3)

2. (a) Draw the different conformers of cyclohexane and arrange them in increasing order of stability.
- (b) Assigning the priority and designate E/Z or R/S to the following :

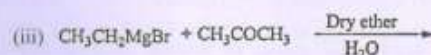
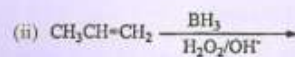
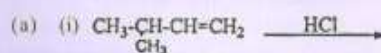


- (c) Convert the following into fischer projection :



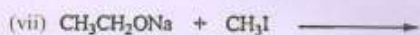
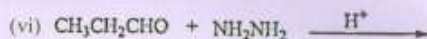
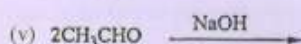
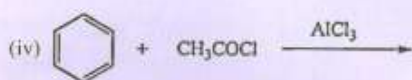
- (d) Define enantiomers and diastereomers with at least one example each. (4,6,2,3)

3. Complete the following reactions (any Six)

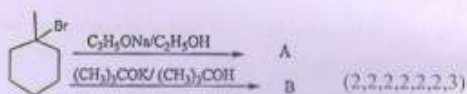


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(b) Write the product.



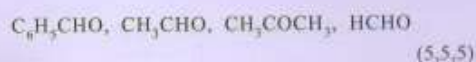
4. Explain the following: (Any three)

- Hydrolysis of 2-Bromo-3-methyl butane gives only 2-methyl-2-butanol.
- Differentiate between E1 and E2 reactions.
- Methyl group in toluene is o, p-directing and activating.

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(d) Arrange the following carbonyl compounds in decreasing order of reactivity towards nucleophilic addition reaction and justify



5. Attempt (Any three)

- Chloro benzene reacts with  $\text{NaNH}_2$  in liquid  $\text{NH}_3$  at room temperature to form aniline. Explain.
- Discuss the mechanism of addition of  $\text{HBr}$  to propene in the presence of peroxide. Explain. Why the peroxide effect is shown by  $\text{HBr}$  only and not by  $\text{HCl}$  and  $\text{HI}$ ?
- Why  $\text{SN}_2$  reaction of alkyl halides are accompanied by inversion of configuration. Explain the mechanism.
- Compare the reactivities of Bromobenzene, Allyl bromide and Bromo ethane in nucleophilic substitution reactions. (5,5,5)

6. Write short note on **any three** of the following with emphasis to (i) the functional group that undergo these reactions (ii) product formed (iii) reaction conditions (iv) mechanism.

P.T.O.



(a) Friedel craft acylation reaction

(b) Birch reduction

(c) Pinacol-pinacolone rearrangement

(d) Perkin reaction

(e) Reimer-Tiemann

(5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1894 C

Unique Paper Code : 32175915

Name of the Paper : GE - Solutions, Phase  
Equilibria, Conductance,  
Electrochemistry & Functional  
Group Organic Chemistry-II

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

Semester : I / III

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. All questions carry equal marks.
4. Attempt six question in all, three question from each Sections
5. Attempt all parts of a question together.
6. Use of scientific calculator and logarithmic table is allowed.

P.T.O.

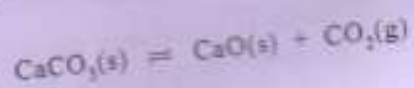
1894

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SECTION A  
Physical Chemistry

1. Attempt any five:

- (a) What are azeotropes? Give an example. Is it possible to separate the components of an azeotropic mixture using simple distillation? Explain.
- (b) Describe the use of quinhydrone electrode for the measurement of pH of a solution.
- (c) Determine the number of components, number of phases and degrees of freedom for the following system:



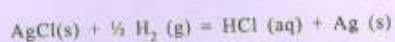
- (d) Draw a labeled phase diagram of water. Using this phase diagram, explain why skating is possible on ice.

- (e) Derive the Clapeyron-Clausius equation in the form  $dP/dT = \Delta H_{vp}/(TVg)$ . Under what conditions can this equation be integrated and how?
- (f) Explain why enthalpy and volume of mixing for the formation of ideal binary solution is zero.  
(5×2.5)
2. (a) State and explain Kohlrausch's law of independent migration of ions. Also, explain the variation of specific conductance, molar and equivalent conductance at infinite dilution of weak and strong electrolytes with suitable graph.
- (b) Give the principle of potentiometric titration. Also give the advantages of potentiometric titration over volumetric titrations using indicators. Why do we prefer potentiometer for the measurement of EMF of a cell over voltmeter?

- (c) Transport number of  $\text{Na}^+$  is 0.463 (dilute solution of  $\text{NaCl}$  in methanol). Calculate transport number for  $\text{H}^+$  (dilute solution of  $\text{HCl}$  in methanol) if  $\Lambda^\infty$  for ( $\text{NaCl}$  in methanol) is  $96.9 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$  and  $\Lambda^\infty$  for ( $\text{HCl}$  in methanol) is  $192 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$  respectively. (4,4,4.5)

3. (a) (i) What is salt bridge? Write its functions emphasizing on its role in eliminating the liquid junction potential in an electrochemical cell.

- (ii) Construct the galvanic cell for the following reaction and write down the expression for the cell potential



- (b) Derive the expression to determine the pH value of an unknown solution by using quinhydrone electrode with well labelled diagram.

- (c) Draw and discuss the well labelled phase diagram of Sulphur system. (4,4,4.5)

4. (a) In water-phenol system, determine phase, component, and degree of freedom

(i) inside the solubility curve

(ii) outside the solubility curve

(iii) at critical solution temperature

- (b) Write short note on any two :

(i) Critical solution temperature

(ii) Moving boundary method

(iii) Nernst distribution law

- (c) For the electrochemical cell:  $\text{Cd}, \text{CdCl}_2, \text{S}/2 \text{H}_2\text{O}_{(\text{aq})} | \text{AgCl}_{(\text{s})}, \text{Ag}$ , the EMF at  $0^\circ\text{C}$  and  $25^\circ\text{C}$  is  $0.6915 \text{ V}$  and  $0.6753 \text{ V}$ , respectively. Calculate  $\Delta G^\circ$ ,  $\Delta S^\circ$ , and  $\Delta H^\circ$  at  $25^\circ\text{C}$ . (4,4,4.5)

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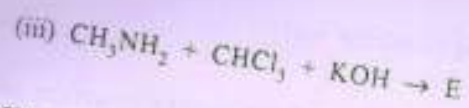
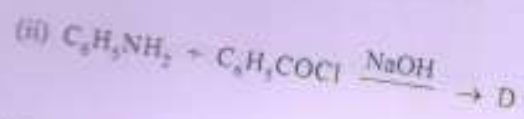
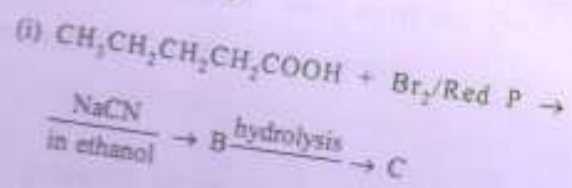
SECTION - B

*Attempt three questions in all.  
All questions carry equal marks.*

5. (a) Write short notes on any two of the following :
- (i) Merrifield solid phase synthesis
  - (ii) Hell-Volhard-Zelinsky reaction with mechanism
  - (iii) Perkin Condensation
- (b) Outline the synthesis of Alanine using Strecker synthesis
- (c) Give the full name of DCC and *t*-BOC and highlight their use in peptide synthesis. (6,3,3,5)
6. (a) Predict the structure of products A to E in the following reactions:

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(b) Differentiate Hoffmann V/s Saytzeff elimination.

(c) Explain Mutarotation with suitable example.

(5,4,3,5)

(a) Name the reaction involved in the conversion of acetamide into methylamine. Explain the mechanism.

(b) Explain with structure, why sucrose is a non-reducing sugar.

(c) How will you convert D-Arabinose into D-Glucopyranose?

P.T.O.

(d) Draw the Haworth projection for  $\alpha$ -D-glucopyranose and  $\beta$ -D-Fructofuranose.

(4,2,5,3,3)

8. Write short notes on the following :

(a) Reformatsky Reaction

(b) Hinsberg test

(c) Primary and Secondary structure of proteins

(4,4,4,4)



[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1467 C  
Unique Paper Code : 32173910  
Name of the Paper : SEC: Chemistry of cosmetics  
and Perfumes  
Name of the Course : B.Sc.(Hons) /B.Sc. (Prog)  
Semester : III/V  
Duration : 2 Hours Maximum Marks : 38

**Instructions for Candidates**

1. Write your Roll No. on the top immediately on receipt of this question paper.
  2. Attempt two questions in all.
  3. All questions carry equal marks.
- 
1. (a) What is the significance of SPF in a sunscreen lotion? Name any two active ingredients used in a sunscreen lotion.

P.T.O.

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2

- (b) Write the characteristics of a good lipstick. Explain the role of waxes and oils in its formulation.
- (c) How are Hair dyes classified? List the merits and demerits of using hair dye.
- (d) Distinguish between the following :
- (i) Talcum powder and Compact powder
  - (ii) Deodorants and Antiperspirants (4,5,5,5)
2. (a) 'A cosmetic can mimic a drug'. Justify the statement. Give the classification of cosmetics on the basis of target group.
- (b) Write short notes :
- (i) Nail lacquers and removers
  - (ii) Vanishing Creams
- (c) Enlist different methods used for the extraction of essential oils? Describe any one of the methods employed in detail.

1467

3

- (d) Explain the role of buffer and thickening agents in a hair shampoo. Also, mention the ingredients used in the preparation of an anti dandruff shampoo. (4,5,5,5)
3. (a) What is a cold cream? Describe the use of borax in the formulation of a Cold Cream.
- (b) Discuss the process of manufacturing of a cosmetic product of your choice.
- (c) Explain the relevance of using preservatives in a cosmetic product. Comment on the use of artificial flavours in cosmetics.
- (d) What is geraniol ? Mention its uses in cosmetics. (4,5,5,5)
4. (a) Discuss the structure of skin. Write some salient features of an ideal skin preparation.
- (b) Describe the composition of a lather shaving cream. What are the highlights of an ideal shaving preparation.

P.T.O.

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(c) What is a hair spray? Write the purpose of its use. How is it packaged?

(d) What are various oral hygiene products? Give the composition of tooth powder. (4,5,5,5)

(1000)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1284 **C**

Unique Paper Code : 32173902/42173923

Name of the Paper : SEC- Basic Analytical  
Chemistry

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

Semester : III/V

Duration : 2 Hours Maximum Marks : 38

**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.
3. Question 1 is compulsory.

1. Attempt **any four** :

- (a) Does precision always ensure accuracy? Explain.
- (b) What are the primary and secondary nutrients present in soil?

P.T.O.

1284

2

- (c) Differentiate between adsorption and partition chromatography.
- (d) What do you mean by hardness of water? How is it expressed?
- (e) Enlist different reasons for pollution of water bodies. (2×4)
2. (a) What are complexometric titrations? Discuss different types of EDTA titrations with suitable examples.
- (b) Explain the principle and procedure involved in ascending paper chromatography.
- (c) Do as directed :
- (i) Express in scientific notation: 555700
- (ii) Give the correct number of significant figures: 0.0050830
- (iii) Round off to three significant figures: 75.8437
- (iv) Express the result in correct number of significant figures:  $344.88 \times 42.62 / 1110.524$ . (3,3,4)

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3. (a) What do you understand by the pH of soil? Explain how it is measured?
- (b) Why water is first passed through cation-exchanger and then through anion-exchanger in the deionisation process.
- (c) In two separate determinations, the concentration of iron in a given sample was found to be (a) 20.19 ppm and (b) 19.20 ppm. Taking the accepted value as 20.00 ppm, calculate the absolute error and relative error as per cent and as parts per thousand in the two determinations. (3,3,4)
4. (a) Define  $R_f$  value. In a paper chromatographic separation, one of the amino acid components travelled a distance of 1.9 cm while the solvent travelled a distance of 5.1 cm. Calculate the  $R_f$  value. Give its units.
- (b) Give the full form of the following (Any Three) :
- (i) EBT (ii) TLC (iii) SHE (iv) BOD
- (c) What do you understand by the term 'dissolved oxygen (DO)'? Describe a method to determine DO in a water sample. (3,3,4)

P.T.O.

5. (a) What is precision? How is it expressed?
- (b) What is pure water? Discuss the various purification techniques?
- (c) Draw the layer structure of soil and discuss its various layers. (3,3,4)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1373 C

Unique Paper Code : 32171301

Name of the Paper : Inorganic Chemistry II :  
s- and p-Block Elements

Name of the Course : B.Sc. (H) Chemistry – CBCS  
(LOCF)

Semester : III

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 five questions in all. Question number 1 is compulsory.
  3. All questions carry equal marks.
- 
1. Explain any five of the following, giving suitable reasons :

P.T.O.

1373

2

- (a) In spite of the ring strain in  $P_4$  molecule, white phosphorus is stable relative to  $P_2$ .
- (b) No reductant is required for the extraction of metals from  $HgO$  and  $Ag_2O$ .
- (c) Helium and Neon do not form clathrate compounds.
- (d) Carbon shows much greater tendency for catenation in comparison to silicon and nitrogen.
- (e) The colour of halogens deepens down the group.
- (f) Lithium forms predominantly the monoxide, sodium forms peroxide whereas potassium, rubidium and cesium form superoxides.
- (g) Ionisation enthalpies of group 13 elements show irregular trends. (3×5)

1373

3

2. (a) Name the hydrides of group 15 elements and discuss the variation in their properties with reference to :
- (i) Basic character
  - (ii) Thermal stability
  - (iii) Reducing character
- (b) Carbon is capable of reducing all metal oxides provided the temperature of reduction is sufficiently high, however the use of carbon as reducing agent becomes impractical for metal oxides towards the bottom of Ellingham diagram. Comment and also explain why most of the lines slope upwards in the Ellingham diagrams.
- (c) Draw the structure of diborane and discuss the bonding involved using molecular orbital theory. Also, give experimental evidences in support of the structure. (4,5,6)

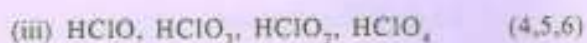
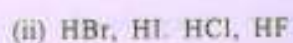
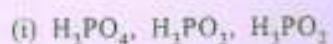
P.T.O.



3. (a) What is diagonal relationship? Giving at least three examples explain how boron resembles silicon.

(b) Give the oxidation states of sulphur in Caro's acid and Marshall's acid. Draw their structures and write one reaction by which both can be differentiated.

(c) Arrange the following in the increasing order of their acidic strength and justify your answer.



4. (a) Draw and discuss the structure of  $\text{P}_2\text{O}_{10}$  and write the mechanism for its hydrolysis.

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(b) Discuss the structure of 3-dimensional silicates with reference to zeolites and their application as ion exchanger.

(c) Comment on any three :

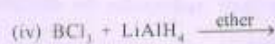
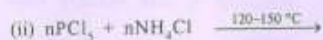
- (i) XOX bond angle in  $\text{Cl}_2\text{O}$  is greater than that in  $\text{F}_2\text{O}$ .
- (ii) Cesium iodide is much less soluble in water than Cesium fluoride, but Lithium fluoride is less soluble than Lithium iodide.
- (iii) Solubility of sulphates of alkaline earth metals decreases whereas it increases for their hydroxides on descending the group.
- (iv) Chlorine has greater electron gain enthalpy than fluorine, yet fluorine is a stronger oxidizing agent.

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(v) Thallium doesn't exist in (III) oxidation state, yet  $Tl_2$  exists. (4,5,6)

5. (a) Explain the dissimilarities between the two allotropic forms of carbon, namely graphite and diamond.

(b) Complete and balance the following equation :  
(any four)



(c) Draw the structure of any three :

(i) Basic beryllium nitrate

(ii) Mg-EDTA complex

(iii) iodine heptafluoride

(iv) 2,2,2-cryptand (5,4,6)

6. (a) Discuss at least three points of similarities between halogens and pseudohalogens.

(b) Alkaline earth metals are harder, denser and have high melting points as compared to alkali metals. Explain.

(c) Write short notes on : (any three)

(i) Cyanide Process

(ii) Zone refining

(iii) Interhalogen compounds

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(iv) Solutions of alkali metal in liquid ammonia  
(3,3,9)

(2000)

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[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1401 C

Unique Paper Code : 32171302

Name of the Paper : Organic Chemistry - II  
(Oxygen Containing Functional Groups)

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

Semester : III

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 five questions in all.

1. (a) An organic compound A ( $C_5H_{10}O_2$ ) on reduction with lithium aluminium hydride ( $LiAlH_4$ ) forms organic compounds B ( $C_3H_8O$ ) and C ( $C_2H_6O$ ). B on oxidation followed by heating with calcium oxide gives D ( $C_5H_{10}O$ ). C on reaction with NaOH/

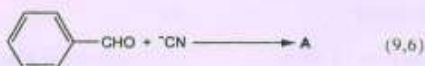
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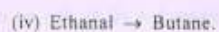
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b forms E and a yellow precipitate of  $\text{CHI}_3$ . Identify the organic compounds A, B, C, D and E. Give the name reaction involved during the conversion of C to E along with mechanism.

- (b) Identify A having molecular formula  $(\text{C}_{14}\text{H}_{12}\text{O}_2)$  in the following reaction. Give the name of the reaction and mechanism involved. Write down the role of cyanide ion in the following reaction :



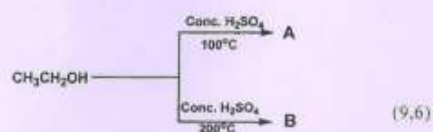
2. (a) Carry out the following conversions (any three) :



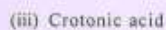
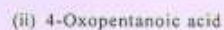
- (b) Identify A and B in the following reaction and justify your answer :

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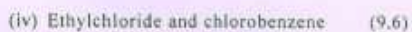
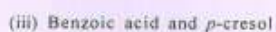
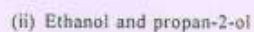
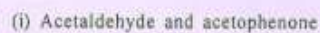
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3. (a) Carry out the synthesis of any three following compounds either from EAA (Ethyl acetoacetate) or DEM (Diethyl malonate) :



- (b) Differentiate between the following (give visible test only) and write down the reaction involved (any three) :



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4. (a) Give reason for the following (any four):

(i) The rate of hydrolysis of the carboxylic acid derivatives is:



(ii)  $\text{S}_{\text{N}}1$  reactions are accompanied by racemization, while  $\text{S}_{\text{N}}2$  reactions result in the inversion of the configuration.

(iii) 2,2-Dimethylpropanal gives Cannizzaro's reaction, while 2-methylpropanal does not.

(iv) Carboxylic acid does not form oxime though they have carbonyl group ( $>\text{C}=\text{O}$ ) in their structure.

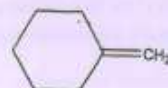
(v) Malonic acid and  $\beta$ -keto carboxylic acid decarboxylate readily on heating  $200^\circ\text{C}$ .

(vi) Ketones cannot be prepared from acid chloride and  $\text{RMgX}$  although they can be prepared from acid chloride and  $\text{R}_2\text{Cd}/\text{R}_2\text{CuLi}$ .

(b) Prepare the following organic compound using Wittig reaction:

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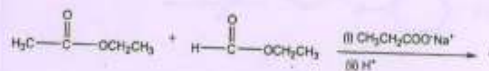
(12,3)

5. (a) Identify the organic compounds (A, B) and explain their formation with the help of mechanism.



OR

Identify the organic compound (A) formed in the following reaction and explain its formation with the help of mechanism.



(b) Benzene on reaction with propene in the presence of a Lewis acid forms A ( $\text{C}_9\text{H}_{12}$ ). A on aerial oxidation forms B ( $\text{C}_9\text{H}_{12}\text{O}_2$ ). B on acidic hydrolysis gives C ( $\text{C}_6\text{H}_6\text{O}$ ) and D ( $\text{C}_3\text{H}_6\text{O}$ ). Identify the organic compounds A, B, C and D.

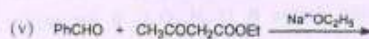
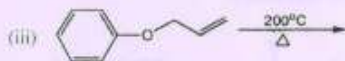
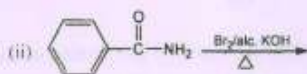
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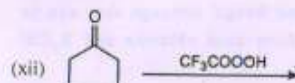
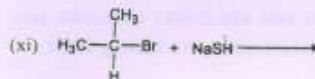
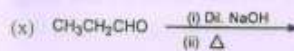
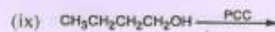
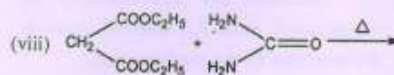
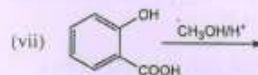
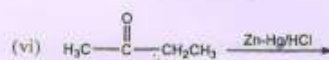
- (c) (i) Write down the products obtained on heating  $\alpha$ ,  $\beta$  and  $\gamma$ -hydroxycarboxylic acid separately.
- (ii) Tertiary alkyl halides are not good substrates for nucleophilic substitution reactions. Explain.
- (iii) *p*-Chlorotoluene on reaction with  $\text{NaNH}_2$  in liq.  $\text{NH}_3$  forms *m*-toluidine along with *p*-toluidine. Explain. (4,2,3,3,3)

6. Complete the following reactions :



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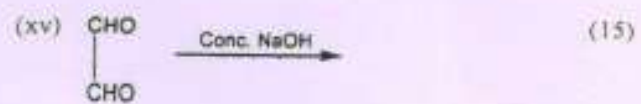
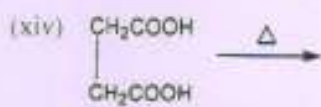
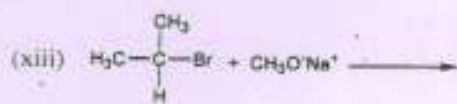


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[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1291 **C**  
Unique Paper Code : 32173909  
Name of the Paper : SEC: Pharmaceutical Chemistry  
Name of the Course : B.Sc. (Hons) / B.Sc. (Prog)  
Semester : III/V  
Duration : 2 Hours Maximum Marks : 38

**Instructions for Candidates**

1. Write your Roll No. on the top immediately on receipt of this question paper.
  2. Attempt **any four** questions.
  3. Each question carries **9.5** marks.
- 
1. (i) Define SAR. Explain with an example. (4)  
(ii) Explain retro-synthetic approach for any drug molecule. (4)  
(iii) What is the difference between pharmacodynamics and pharmacokinetics studies of a drug molecule? (1.5)
  2. (i) Write short note on **any one** of the following : (4)  
(a) DNA based antiviral drugs with example.  
(b) NSAIDs

P.T.O.

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- (ii) Describe the synthesis of vitamin B12 by fermentation. (4)
- (iii) What are barbiturates? Give **one** example. (1.5)
3. (i) Give the synthesis of any one antilaprosyl drug. (4)
- (ii) Define the term pharmaceutical aids. Give two examples with their uses. (4)
- (iii) Explain surface, submerged and solid-state fermentation process. (1.5)
4. (i) Mention the side effects of thalidomide and cetirizine. (4)
- (ii) Explain different steps in drug development. (4)
- (iii) Give two examples of drug molecules derived from plants. (1.5)
5. (i) Describe the fermentation process for production of citric acid. (4)
- (ii) Define following terms with suitable examples : (2×2=4)
- (a) Central nervous system agents
- (b) beta-lactam nuclei based antibiotics
- (iii) Define the term 'prodrug' with suitable example. (1.5)
- (1000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1705 **C**

Unique Paper Code : 42174304

Name of the Paper : Solutions, Phase Equilibria,  
Conductance, Electrochemistry  
& Functional Group Organic  
Chemistry-II

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

Semester : III

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. **Section A** and **Section B** carry equal marks
3. Use separate answer sheets for **Section A** and **Section B**.
4. Use of simple calculator is allowed.

P.T.O.

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## SECTION A

*(Attempt any three questions in all.)*

1. Explain Why?

- (a) (i) Metallic conductance decreases while electrolytic conductance increases with rise of temperature.
- (ii) A DC current cannot be used for conductance measurements.
- (iii)  $H^+$  and  $OH^-$  ions have exceptionally high ionic conductivities.
- (b) State and explain Kohlrausch's law of independent migration of ions. How this law is useful to obtain,  $\Lambda^\infty$ , molar Conductance of weak electrolyte at infinite dilution?
- (c) The conductance of a cell containing an aqueous 0.0560 M KCl solution is  $0.0239 \Omega^{-1}$ . when the same cell is filled with an aqueous 0.0836 M NaCl solution, its conductance is  $0.0285 \Omega^{-1}$ . Given that

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the equivalent conductance of KCl is  $134.5 \Omega^{-1} \text{equiv}^{-1} \text{cm}^2$ , calculate the equivalent conductance of NaCl solution. (3+1.5,4,4)

2. (a) Find:

- (i) F (degree of freedom) for a system consisting of solid sucrose in equilibrium with aqueous sucrose solution.
- (ii) F (degree of freedom) for an aqueous solution of weak acid HCN.
- (b) State Nernst Distribution law. Also discuss the preconditions of its validity.
- (c) Draw and label Phase diagram of Sulphur.
- (d) Define CST (taking example of Phenol - Water system). How is it different from MST. Draw temperature - composition curve for Phenol-Water system and label appropriately. (2+1.5,3,3,3.5)

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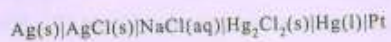
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3. (a) Write the Anodic, Cathodic and overall cell reaction for the following electrochemical cell



What is the term used for this type of cells.

- (b) Consider the following cell:



The standard emfs of the cell at several temperatures are as follows :

T/K	291	298	303	311
$E^0/\text{mV}$	43.0	45.4	47.1	50.1

Calculate the values of  $\Delta G^\circ$ ,  $\Delta S^\circ$  and  $\Delta H^\circ$  for the reaction at 298 K.

- (c) Discuss briefly the principle underlying the potentiometric titrations, explaining schematic curve for the potentiometric titrations of strong acid vs strong base. Name one reference and an indicator electrode which can be used in laboratory for acid-base titration. (4,4,4.5)

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4. Write short notes on any five of the following. Draw labeled diagram where ever required

(a) Steam Distillation

(b) Azeotropes

(c) Gibb's phase rule

(d) Conductometric titrations (acid - base)

(e) Simple Eutectic system (Pb - Ag)

(f) Calomel electrode (5×2.5=12.5)

#### SECTION B

(Attempt any three questions in all.)

5. (a) Synthesize Ala-Gly by using Merrifield Solid phase peptide synthesis.
- (b) What is Perkin Condensation? Explain its mechanism.

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- (c) Explain the methods to determine N-terminal and C-terminal ends in proteins. (4,5,4,4)
6. (a) Give the products and the name of the reaction when :
- Aniline reacts with Benzoyl Chloride in basic medium
  - Fructose reacts with excess of phenyl hydrazine.
  - Benzene diazonium chloride reacts with Aniline at low temperature ( $0^{\circ}\text{C}$ - $5^{\circ}\text{C}$ ).
- (b) Draw the Haworth projections formula for (i)  $\alpha$ -D-Glucopyranose (ii)  $\beta$ -D- Fructofuranose.
- (c) Giving suitable explanation arrange the acid derivatives (ester, acid chloride, acid anhydride and amide) in increasing order of reactivity towards nucleophilic acyl substitution reaction. (3×1.5,2×2,4)

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7. (a) How can D-aldopentose be converted into D-aldohexose? Give name of the reaction involved.
- (b) Convert :
- Aniline to p-Nitro aniline
  - o-Toluidine to o-Cresol
- (c) An aliphatic amine with molecular formula  $\text{C}_2\text{H}_7\text{N}$  exists in two isomeric forms 'A' and 'B'. When warmed with chloroform and KOH only 'A' reacts resulting into foul smell. What are the structures and names of 'A' and 'B'? Give name of the reaction and chemical equation involved in it. Compare the basicity of 'A' and 'B'. (4,5,2×2,4)
8. (a) Discuss the Hinsberg test used for identification of  $1^{\circ}$ ,  $2^{\circ}$ ,  $3^{\circ}$  amines. Outline the chemistry involved.
- (b) Arrange the following in the order of increasing acidic strength and justify your answer:

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(i)  $C_6H_5COOH$ ,  $CH_3COOH$ ,  $p\text{-NO}_2C_6H_4COOH$

(ii)  $CH_3COOH$ ,  $ClCH_2COOH$ ,  $BrCH_2COOH$

(c) How will you prepare the following :

(i) Alanine using Strecker synthesis

(ii) Ethyl amine using Gabriel-Phthalimide  
synthesis (4.5, 2×2, 2×2)

(1000)



[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1005 C

Unique Paper Code : 32171501

Name of the Paper : Organic Chemistry IV:  
Biomolecules

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

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 6 questions. All Questions carry equal marks.

1. (a) (i)  $\beta$ -D-Glucose and  $\alpha$ -D-Glucose have different specific rotations. When either anomer is dissolved in water, their rotations change until a fixed value results. Name the term used to describe this change and discuss the mechanism. (3)
- (ii) Draw Fisher projection of  $\beta$ -D-glucose, convert it to Haworth structure and then to the chair conformation. (3)

P.T.O.

- (b) A pentapeptide X having an empirical composition, Lys, Phe, Thr, Leu, Asp, gave DNP-Thr on treatment with DNFB followed by hydrolysis. Treatment of X with Carboxypeptidase released Asp. Treatment of X with Trypsin gave a tripeptide, (Lys, Leu, Thr) and a dipeptide (Asp, Phe). Elucidate the sequence of amino acids in X. What products are obtained on treatment of X with Chymotrypsin? (6.5)
2. (a) Differentiate between nucleosides and nucleotides. Draw the structure of Cytidine. (4)
- (b) Define acid value and saponification value of an oil. Calculate the saponification value of glyceryl tripalmitate. (4.5)
- (c) When D-Glucose is treated with dilute aqueous alkali, a mixture of D-Mannose, D-Fructose and D-Glucose is obtained. Explain the mechanism of this reaction. What is the name of this reaction? 4
3. (a) Outline significant differences between catabolism and anabolism. (3)
- (b) Which steps in glycolysis consume ATP and which ones produce ATP? How many molecules of ATP are obtained from each molecule of glucose that is metabolized to pyruvate? (3.5)
- (c) What is transcription. Explain. (6)

4. (a) Give the structure of disaccharide maltose. How was the nature of linkage between its two monosaccharide units established? (3)
- (b) Give the reaction catalysed by the following enzymes. To which class of enzymes do they belong according to enzyme commission
- (i) Phosphofructokinase
- (iii) Fumarase (4)
- (c) Explain the principle of electrophoresis. How can it be used to separate a mixture of Alanine, Lysine and Glutamic acid? (3.5)
- (d) Give the structure of NAD<sup>+</sup>. (2)
5. (a) Explain oxidative rancidity in oils and fats giving an example. Suggest a method to prevent it. (4)
- (b) Explain the term hardening of oils by taking a suitable example. (4)
- (c) Explain the process of replication? (4.5)
6. (a) Discuss the effect of substrate concentration on the activity of an enzyme. (4.5)
- (b) Give the products from the reaction of methyl  $\alpha$ -D-Glucopyranoside with HIO<sub>4</sub>. (2)

- (c) Discuss the various steps involved in the TCA cycle giving the names of enzymes and structures of intermediates. (6)
7. (a) (i) Explain the use of dicyclohexylcarbodiimide (DCC) in peptide synthesis. Use chemical reactions to illustrate. (3)
- (ii) Outline the synthesis of either Methionine or Proline using any method. (3.5)
- (b) A carbohydrate X with molecular formula  $C_{12}H_{22}O_{11}$  gives a positive test with Benedict reagent, it forms an osazone and undergoes mutarotation. Hydrolysis with aqueous acids or by emulsin produces only D-Glucose. Methylation of X gives an octamethyl derivative which on hydrolysis affords 2,3,4,6 tetra O-methyl D-Glucose and 2,3,4 tri-O-methyl D-Glucose. Work out the structure of X. (6)
8. (a) Give the reactions involved in Killiani -Fischer synthesis starting with D-arabinose. What is the stereochemical relationship between the aldohexoses obtained? (4)
- (b) What is allosteric inhibition? Explain using an example. (4.5)
- (c) What are the different types of RNA? Explain the role of any one of them. (4)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1191

C

Unique Paper Code : 32177908

Name of the Paper : DSE - 2 Green Chemistry

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 five questions. All parts of a question should be attempted together.
3. Each question carries 15 marks.

1. (a) Green chemistry is not only beneficial in terms of EHS (Environmental Health and Safety) parameters but also provides a sustainable solution in business. Justify.  
  
(b) What factors should be considered before designing a chemical synthesis so that it a part of green chemistry evaluation? What are the barriers in pursuit of Green Chemistry?

P.T.O.

- (c) (i) "Supercritical carbon dioxide is a safer solvent." Discuss in relevance to Green Chemistry citing any two examples.
- (ii) Give any two chemical reactions which have 100% atom economy. (5,5,5)
2. (a) How conventional plastics are posing environmental threat. Give example where this threat can be subdued using green methodology? Also discuss, which principles of green chemistry are referred here?
- (b) Write down the conventional and green method of preparation of adipic acid. Also discuss the limitations of conventional method and the advantages of the green methodology in the preparation.
- (c) (i) What is 'Carbon Neutral Balance'? Why Bio-solvents/ bio-derived solvents do not disturb this balance as done by petroleum based solvents?
- (ii) Explain: Risk = Function (Hazard, Exposure) (5,5,5)
3. (a) What are trans-fats? Are they good for health?

- Highlight the role of enzymes in interesterification for the production of non-trans fats and oils. What are the advantages of enzymatic esterification over chemical interesterification?
- (b) (i) State and explain the pollution prevention act of 1990 passed by US Congress,
- (ii) What do you understand by depleting feedstock? Give example.
- (c) How microwaves provide a greener alternative to conventional heating methods? Write the following reactions under microwave irradiation :
- (i) Saponification of ester
- (ii) Diels Alder reaction (5,5,5)
4. (a) Illustrate the principle of inherent safer design (ISD) and explain the statement- "What you don't have cannot harm you" in terms of green chemistry.
- (b) Provide one example of the following :
- (i) Greener alternative to dry cleaning solvent
- (ii) Essential oil isolated using liq. CO<sub>2</sub>
- (iii) Green oxidizing agent
- (iv) Green methylating reagent
- (v) Green alternative to THF

- (c) How does catalysis help in making reaction greener as compared to stoichiometric reagents? Give one example each of photocatalysis and asymmetric catalysis. (5,5,5)
5. (a) Bhopal gas tragedy is one of the most disastrous chemical accidents. Which gas was responsible of the tragedy? Discuss the synthetic method (chemical reaction) of carbaryl production used in the plant and also suggest a greener alternative to the methodology.
- (b) Sonochemical Simmons-Smith reaction is a better alternative to conventional method. Comment.
- (c) What are fluoruous biphasic solvents? Discuss the limitations and one valuable application of the solvent system. (5,5,5)
6. Write short notes on **any five** of the following topics (mention the relevant things briefly):
- (i) Co-crystal controlled solid state synthesis.
  - (ii) Avoidance of unnecessary derivatization.
  - (iii) Cradle to Cradle Carpeting
  - (iv) Life cycle assessment (LCA)
  - (v) Green wood preservatives
  - (vi) Circular economy

(5×3)

(1000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1093

Unique Paper Code : 32177902

Name of the Paper : DSE- Inorganic Materials of  
Industrial Importance

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

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 **SIX** questions in all.
3. Question 1 is compulsory.
4. Attempt any **five** other questions.

1. (a) Give one word for the following / Fill in the blanks as required :

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- (i) A device which converts fuel directly into electricity without combustion.
- (ii) The process of applying a protective zinc coating to iron.
- (iii) Notation on a bag of fertilizer signifying that it contains 12% N, 10% P ( $P_2O_5$ ), and 10% K ( $K_2O$ ).
- (iv) Presence of the compound in urea fertilizer that can result in toxicity to plants.
- (v) Low refractive index materials, generally white in color, which are added to a paint formulation to increase its volume.

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- (vi) The protecting power of a surface coating increases with \_\_\_\_\_ in porosity.
  - (vii) Borosilicate glasses are known for having \_\_\_\_\_ coefficient of thermal expansion.
- (b) Distinguish between the following :
- (i) Silicate and non-silicate glass
  - (ii) Oil based and Water based paints
- (c) Write short notes on :
- (i) Potassium fertilizers
  - (ii) Heat resistant paints (7,4,4)

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2. (a) Explain the working of lithium-ion battery. Describe the intercalation and deintercalation process taking place in this battery.
- (b) How does a hydrogen fuel cell work? Give the reactions involved.
- (c) What do you mean by a solid-state battery? What are the advantages of a solid-state electrolyte battery over the liquid electrolyte battery? (4,4,4)
3. (a) What is a fertilizer? What are the requisites for a compound to be a good fertilizer?
- (b) Explain the manufacture, properties, and applications of Urea as a fertilizer.
- (c) Discuss the importance of super alloys giving at least two examples. (4,4,4)

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4. (a) What are ceramics? Why is glazing done for ceramic articles?
- (b) What is Portland cement? What makes the cement, a quick setting cement?
- (c) Discuss the characteristics and applications of the following :
- (i) Photochromic glass
- (ii) Safety glass (4,4,4)
5. (a) Describe the formation, and applications of the following forms of carbon :
- (i) Fullerenes
- (ii) Carbon fibers
- (b) What are semiconducting oxides? Explain giving examples.

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(c) How are nanomaterials different from their bulk counterparts? Explain with reference to the changes in properties shown by the nanomaterials? (4,4,4)

6. (a) Define Pigment Volume Concentration (PVC) and Critical Pigment Volume Concentration (CPVC). Mention the functions of the following additives in a paint formulation (Any Two):

(i) Thinner

(ii) Plasticizer

(iii) Fillers

(b) What is the principle of electroplating? Discuss the process and utility of electroplating for metallic coatings.

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(c) Discuss the technique by which coatings employing metal spraying are applied on a surface. (4,4,4)

7. (a) What are emulsion paints? What is their drying mechanism?

(b) Why is it necessary to add a retardant to cement? Give an example of a retardant and explain with chemical reactions how it functions in retarding the setting of cement.

(c) What are alloys? Discuss the alloys of aluminium and copper. (4,4,4)

8. (a) What are thermosets and thermoplastics? Explain giving example in each case.

(b) What are optical fibres? How do signals travel through them?

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(c) What are primary and secondary batteries? What are the characteristics of an ideal battery?

(4,4,4)

(1000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1041 **C**

Unique Paper Code : 32171502

Name of the Paper : Physical Chemistry V: Quantum  
Chemistry & Spectroscopy

Name of the Course : B.Sc. (Hons) 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 six questions in all, three questions each from Sections A and B.
3. Attempt all part of a question together.
4. All questions carry equal marks.
5. Use of a non-programmable scientific calculator is allowed.

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**Physical constants**

Atomic mass unit	$= 1.66 \times 10^{-27} \text{ kg}$
Planck's constant	$= 6.626 \times 10^{-34} \text{ J s}$
Velocity of Light	$= 3 \times 10^8 \text{ m s}^{-1}$
Boltzmann constant	$= 1.381 \times 10^{-23} \text{ J K}^{-1}$
Mass of Electron	$= 9.1 \times 10^{-31} \text{ kg}$
Avogadro's number	$= 6.023 \times 10^{23} \text{ mol}^{-1}$
Nuclear magneton	$= 5.05 \times 10^{-27} \text{ J T}^{-1}$
Bohr magneton	$= 9.274 \times 10^{-24} \text{ J T}^{-1}$

**SECTION A****(Quantum Chemistry)**

- (a) Discuss the postulates of quantum mechanics.
- (b) Write the complete Hamiltonian operator for Li atom explaining all the terms. Write the modified Hamiltonian operator after applying Born Oppenheimer approximation.
- (c) Show that the eigenvalues of a Hermitian operator are always real. (4,5,4,4)

- (a) A particle of mass  $m$ , in a one-dimensional box of length  $a$  can be represented by the function,

$$\psi_n = \sin \frac{n\pi x}{a} \quad (n = 1, 2, 3, \dots)$$

Normalize the given function  $\psi_n$  and find whether it is an eigen function of (i)  $\hat{p}_x$  (ii)  $\hat{p}_x^2$ .

- (b) A particle of mass,  $m$ , in a one-dimensional box of length  $a$  can be represented by the following normalized trial wave function where  $N$  is the normalization constant.

$$\psi_{\text{trial}} = N \{x(a-x)\}$$

- Calculate the expectation value of energy,  $\langle E \rangle$ , of this particle in the ground state using the trial wave function.
- Compare this energy with the actual energy. Calculate the percentage error.
- Is the trial wave function acceptable? Explain on the basis of variation theorem. (4,5,(4,2,2))

P.T.O.

3. (a) Plot the radial functions and radial probability distribution functions for an electron in hydrogen atom for all wave functions having  $n = 2$ . Write the number of nodes in each case.

(b) Evaluate the expectation value of the radius,  $\langle r \rangle$ , at which the electron in the ground state of Hydrogen atom ( $Z=1$ ) is found. Given the wave function for this state is

$$\psi_{1,0,0} = \frac{1}{\sqrt{\pi}} \left( \frac{Z}{a_0} \right)^{3/2} e^{-Zr/a_0} \text{ where } a_0 \text{ is the Bohr radius}$$

$$\text{and } \int_0^{\infty} r^n e^{-ar} dr = \frac{n!}{a^{n+1}}$$

(c) Giving reason, state which of the following are acceptable wave functions in the indicated interval.

(i)  $\sin x$   $(0, 2\pi)$

(ii)  $e^{-x}$   $(-\infty, \infty)$

(iii)  $\frac{1}{x}$   $(0, \infty)$

(iv)  $\sin^{-1} x$   $(-1, 1)$  (4.5,4,4)

4. (a) By applying the procedure of separation of variables on the following Schrodinger equation for an electron in a hydrogen atom, derive three equations, one dependent on variable,  $r$ , second dependent on variable,  $\theta$  and third dependent on variable,  $\phi$ . In this equation  $\psi(r, \theta, \phi)$  is the function of three independent variables  $r$ ,  $\theta$  and  $\phi$ . Considering  $\psi(r, \theta, \phi) = R(r) * \Theta(\theta) * \Phi(\phi)$ ,

$$\left[ -\frac{\hbar^2}{2m} \left( \frac{d^2}{dr^2} + \frac{1}{r^2} \frac{d}{d\theta} \left( \sin^2 \theta \frac{d}{d\theta} \right) + \frac{1}{\sin^2 \theta} \frac{d^2}{d\phi^2} \right) - \frac{Ze^2}{r} \right] \psi = E\psi$$

(b) Set up the Hamiltonian operator for a particle oscillating about a mean position (a simple harmonic oscillator). Explain the significance of zero-point energy of a simple harmonic oscillator.

(c) Starting from the expression for total energy of a rigid rotator, setup the Schrodinger equation for the system in Cartesian coordinates.

(4.5,4,4)

P.T.O.

**SECTION B**  
**(Spectroscopy)**

5. (a) Chlorine gas is microwave and infra-red inactive but Raman active. Explain.
- (b) How will the microwave spectrum of  $\text{HCl}^{35}$  change if  $\text{Cl}^{35}$  is replaced by  $\text{Cl}^{37}$ ?
- (c) The rotational spectrum of  $^{79}\text{Br}^{19}\text{F}$  shows a series of equidistant lines  $0.71433 \text{ cm}^{-1}$  apart. Calculate the rotational constant, B, the moment of inertia and bond length of the molecule. (4.5,4,4)
6. (a) How do the P, Q and R branches arise in the Vibrational-Rotational spectrum. Why is Q branch not observed for most of the heteronuclear diatomic molecules?
- (b) What is the ratio of the number of protons in each spin state at temperature 300 K, given that the  $^1\text{H}$  NMR spectrometer is operating at 60MHz and  $g_n = 5.585$  for the  $^1\text{H}$  nucleus.

- (c) The fundamental and first overtone transitions of  $^{14}\text{N}^{16}\text{O}$  are centered at  $1876.06 \text{ cm}^{-1}$  and  $3724.20 \text{ cm}^{-1}$ , respectively. Calculate the equilibrium vibration frequency and anharmonicity constant. (4.5,4,4)
7. (a) A molecule  $\text{AB}_2$  has the following Infrared and Raman spectra :

$\nu \text{ (cm}^{-1}\text{)}$	Infrared	Raman
519	Active (PQR)	Active (Polarized)
1151	Active (PQR)	Active (Polarized)
1367	Active (PQR)	Active (Depolarized)

- Predict the geometry of the molecule with justification and assign the observed wavenumbers to the specific vibration mode.
- (b) What is Raman effect? Explain the origin of Stokes and Anti-Stokes line.
- (c) Arrange the following groups in increasing order of their absorption frequencies: Give Justification

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(i) CF, CCl, CBr, CH

(ii) C-C, C=C, C=C (4.5,4,4)

8. (a) A  $^1\text{H}$  NMR spectra of an organic compound with the molecular formula  $\text{C}_3\text{H}_6\text{Br}_2$  gives three signals (p1, p2 and p3) with their respective intensity ratios as follows: 1(sixtet): 2 (doublet): 3(doublet) ( $\delta$  values are in the order  $p1 > p2 > p3$ ). Write the probable structure and justify your answer.

(b) Write short notes on any two of the following :

(i) Difference between internal conversion and intersystem crossing.

(ii) Factors affecting the intensity of transition.

(iii) Larmor precession. (4.5,4,4)

(1000)



[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1519 **C**

Unique Paper Code : 42177925

Name of the Paper : DSE - Chemistry of d-block  
Elements, Quantum Chemistry  
and Spectroscopy

Name of the Course : B.Sc. Program

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 **six** questions in total with **three** from **SECTION A** and **three** from **SECTION B**.
3. Attempt **SECTION A** and **SECTION B** on separate answer sheets.
4. Use of scientific calculator and Log table is allowed.

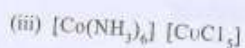
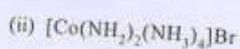
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## SECTION A

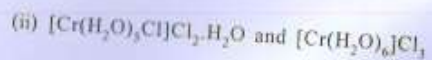
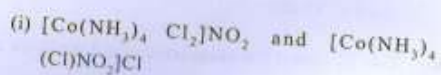
## INORGANIC CHEMISTRY

Attempt ANY THREE questions. Attempt any three questions in this section. All questions carry equal marks.

1. (a) Name any three of the following complexes according to the IUPAC system of nomenclature:



- (b) Indicate the isomerism exhibited in the following pairs of compounds and give one method to distinguish between them:



- (c) Give brief reasons for any two of the following:

(i) The densities of the metals of the third transition series is almost twice that of the corresponding metals of the second transition series.

(ii) An aqueous solution of copper sulphate is blue while that of zinc sulphate is colourless.

(iii) Ca & Sc<sup>3+</sup> are isoelectronic but have different electronic configuration.

(4.5,4,4)

2. (a) Write the formulae of any three of the following according to IUPAC convention:

(i)  $\mu$ -oxidobis(pentaamminechromium(III)) ion

(ii) Hexaamminechromium(III) pentacyanidocuprate(II)

(iii) Tetraamminchloridomanganese(III) nitrate

(iv) Caesium tetrafluoridooxidochromate(III)

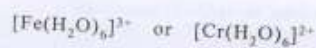
- (b) Why is  $TiCl_3$  coloured while  $TiO_2$  is colourless? Can this reason explain the colour of  $KMnO_4$ ? If not, then assign the reason.

P.T.O.

(c) Predict the appropriate choice and give brief reasons :

- (i) Greater Stability Ti(IV), Ti(III)  
 (ii) Higher number of oxidation states Mn Fe  
 (4.5,4,4)

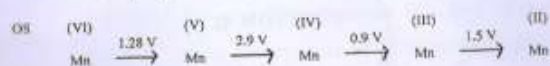
3. (a) The complex  $[\text{CoCl}_2(\text{en})_2]^+$  exists in two isomeric forms A & B. A is optically active where as B is optically inactive. Draw the structures of A & B and explain briefly.  
 (b) State Jahn Teller theorem. Giving suitable reason, explain which of the following complexes will be distorted.



(c) Calculate CFSE in terms of  $\Delta_0$  of a  $d^4$  metal ion placed in a tetrahedral field. Draw the splitting diagram. (4.5,4,4)

4. (a) For  $\text{Mn}^{3+}$  ion, the electron pairing energy,  $P$  is  $28000 \text{ cm}^{-1}$ ,  $\Delta_0$  values for the complexes  $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$  and  $[\text{Mn}(\text{CN})_6]^{3-}$  are  $21000 \text{ cm}^{-1}$  and  $38500 \text{ cm}^{-1}$ , respectively. Do these complexes have low spin or high spin configuration? Calculate CFSE for both the configurations to justify your answer.

(b) Given below is the Latimer diagram for Manganese :



Answer the following questions :

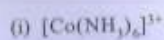
- (i) Giving suitable reason, identify oxidation states which will disproportionate  
 (ii) Calculate the skip step potential for  $\text{Mn(VI)}$  -----  $\text{Mn(IV)}$

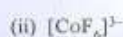
OR

(b) Briefly discuss any two of the following :

- (i) Lanthanoid Contraction and its consequences.  
 (ii) Inner and outer orbital complexes  
 (iii) Complex formation tendency of d - block elements.

(c) Using VBT predict the geometry and magnetic behaviour of :





(4.5,4,4)

## SECTION B

Planck's constant,  $h = 6.626 \times 10^{-34} \text{ Js}$ ;Velocity of light,  $c = 3 \times 10^8 \text{ ms}^{-1}$ Mass of an electron,  $m_e = 9.1 \times 10^{-31} \text{ kg}$ 

Attempt any three questions.

- State Lambert Beer's law. A substance when dissolved in water at  $10^{-3}$  molar concentration absorbs 10% of the incident radiation in a cell of path length 1 cm. What should be the concentration of the solution in order to absorb 90% of the same radiation?
  - Discuss the effect of isotopic substitution on microwave spectrum of diatomic molecules. The rotational constant for  $\text{H}^{35}\text{Cl}$  is observed to be  $10.59 \text{ cm}^{-1}$ . What are the values of B for  $\text{H}^{37}\text{Cl}$ .
  - Explain the difference between internal conversion and intersystem crossing. (4.5,4,4)

- In photo-bromination of cinnamic acid, a radiation of wavelength 435.8 nm with an intensity of  $1.4 \times 10^{-3} \text{ Js}^{-1}$  was 80% absorbed in a litre of the solution during an exposure of 1105 seconds. The concentration of  $\text{Br}_2$  is decreased by  $7.5 \times 10^{-5}$  moles/litre. Calculate the quantum yield of the reaction.
  - Prove that the wave functions of a particle in a one-dimensional box are normalized.
  - What is the essential condition for obtaining a microwave spectrum? Which of the following molecules will be microwave active:  $\text{H}_2$ ,  $\text{HCl}$ ,  $\text{CO}$ ,  $\text{CH}_3\text{Cl}$ ? (4.5,4,4)
- What is zero point energy for a particle in one dimensional box? Is the occurrence of zero point energy in accordance with Heisenberg's uncertainty principle?
  - With the help of a suitable diagram, explain the process of fluorescence.

(c) Solve Schrodinger wave equation for a particle of mass 'm' moving in 1-D box of length 'l'. Calculate the ground state energy (in  $\text{kJ mol}^{-1}$ ) for an electron that is confined to a one-dimensional infinite potential well with a width of 0.2 nm. (3.5,4,5)

4. (a) The fundamental vibrational frequency of HCl molecule is found to be  $2,890 \text{ cm}^{-1}$ . Calculate the force constant of the molecule. The atomic masses are  $^1\text{H} = 1.673 \times 10^{-27} \text{ kg}$ ;  $^{35}\text{Cl} = 58.06 \times 10^{-27} \text{ kg}$ . What will be the value of zero point energy for the same?

(b) What is meant by the terms Chromophores and Auxochromes? Give suitable examples.

(c) Calculate the average value of  $p_x$  for a particle in a one-dimensional box of length a. (4.5,4,4)