[This question paper contains 8 printed pages.]

14 **Your Roll No.** 2024

Sr. No. of Question Paper : 1545 **G**

Unique Paper Code : 2172011101

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

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

Semester : I

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

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

P.T.O.

1. Attempt **any five** of the following

(i) What is meant by Dipole moment? Can its magnitude give an idea about the structure of molecules? Explain.

(ii) Why NaCl is soluble in water but AgCl is not?

(iii) The first electron ionization enthalpy of boron (B) is smaller than that of carbon (C) whereas the second electron ionization enthalpy of carbon is smaller than boron.

(iv) Orbitals of 1p, 2d, 4g not possible.

(v) The electron gain enthalpy of chlorine (Cl) is greater than fluorine (F).

(vi) Calculate the effective nuclear charge of 4s and 3d electron in Scandium using Slater's rule.

(5×3)

2. (i) Write the time independent Schrödinger wave equation for hydrogen atom and explain the terms used in it.

(ii) Why half filled and fully filled configurations are more stable than the other configurations.

(iii) Draw Born Haber Cycle and calculate the enthalpy of formation (ΔH_f) for MgF_2 using following data,

Sublimation Enthalpy of Mg = 146. 4 kJ/mol

Ionization Enthalpy of Mg to Mg^{2+} = 2184 kJ/mol

Dissociation Energy of F_2 = 158.9 kJ/mol

Electron gain enthalpy of F(g) = -334.7 kJ/mol

Lattice Energy of MgF_2 = -2922.5 kJ/mol

(iv) Calculate the limiting radius ratio (r^+/r^-) of an ionic lattice having the octahedral geometry with co-ordination number 6 around cation.

(2.5×2,5,5)

3. (i) What is normalized and orthogonal wave function? Write the mathematical expression for normalization and orthogonality of wave function.

(ii) The bond angle in CH_2F_2, HCH = 112.3° and FCF = 108.3°. Calculate the s character used by carbon atom in the orbital directed to the hydrogen and fluorine. Discuss the result in terms of Bent rule.

(iii) Draw the shape of the following molecules using VSEPR theory.

ClF_3, BrF_2^+, PCl_3, $SnCl_2$, OF_2 (5,5,5)

4. (i) Calculate ionic radii for Na^+ & K^+ ions if the internuclear distance in NaF is 231 pm.

(ii) The so-called Lyman series of lines in the emission spectrum of hydrogen corresponds to transitions from various excited states to the n = 1 orbit. Calculate the wavelength of the lowest-energy line in the Lyman series. In what region of the electromagnetic spectrum does it occur?

(iii) Draw the molecular orbital diagram of N_2 and O_2 molecules and explain their magnetic behavior.

(5,5,5)

(i) Based on their positions in the periodic table, arrange these ions in order of increasing radius: Cl^-, K^+, S^{2-}, and Se^{2-}

4. (i) Calculate ionic radii for Na^+ & K^+ ions if the internuclear distance in NaF is 231 pm.

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(5,5,5)

5. (i) Based on their positions in the periodic table, arrange these ions in order of increasing radius: CI^-, K^+, S^{2-}, and Se^{2-}

(ii) The bond distance between H and F in HF molecule is 91.7 pm and the experimentally observed dipole moment of this molecule is 6.6×10^{-30} Cm. Find out the percent ionic character.

(iii) Write the Born Lande equation and the Kapustinskii equation for lattice energy and define the terms involved. What is the advantage of Kapustinskii over Born Lande equation? (5,5,5)

6. (i) Calculate the electronegativity of F from the following data, electronegativity of hydrogen is 2.1, E_{F-F} bond dissociation energies = 36.6 kcal/mol, E_{H-H}= 104.2 kcal/mol, E_{H-F}= 136.6 kcal/mol.

(ii) Draw the radial distribution curve of 1s, 2s, 2p, 3p, and 3d.

(iii) Draw the MO diagram of CO with sp mixing. On the basis of it, explain it is an electron pair donor.

(5,5,5)

7. (i) What is resonance? Draw the resonating structure of NO_2, CO and O_3.

(ii) Write the conditions for a wave function ψ acceptable to the Schrodinger wave equation. What is the physical significance of ψ and ψ^2.

(iii) How will you convert the Cartesian co-ordinates (x, y, z) into polar co-ordinates (r, θ, ϕ)

(5,5,5)

8. (i) Write short notes **(any two)**

(a) Heisenberg Uncertainty Principle

(b) Equivalent and Non-equivalent hybrid orbitals.

(c) Different scales of electronegativity.

(ii) Which of the following combinations are allowed in LCAO (considering Z axis as molecular axis) and sketch the shapes of molecular orbitals formed by their addition and subtraction

(a) s and p_z

(b) p_x and p_x

(iii) List the limitations of:

(a) Bohr's Theory of atomic structure.

(b) Radius ratio rule. (5,5,5)

[This question paper contains 8 printed pages.]

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Sr. No. of Question Paper : 1583 G

Unique Paper Code : 2172011102

Name of the Paper : DSC – Basic Concepts and Aliphatic Hydrocarbons (Organic Chemistry I)

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

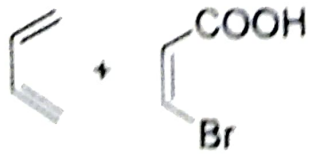
Semester : I

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **six** questions.
3. Each question carries **15** marks.

1. Complete the following :

(i) 

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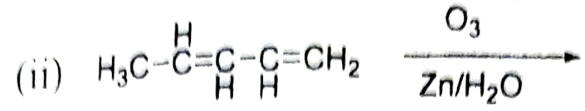
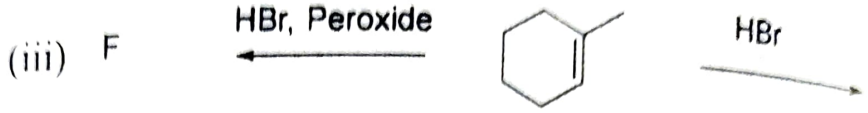
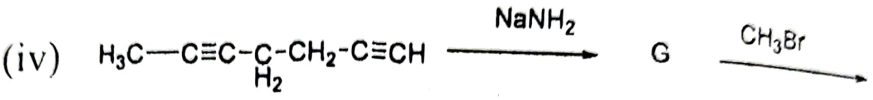
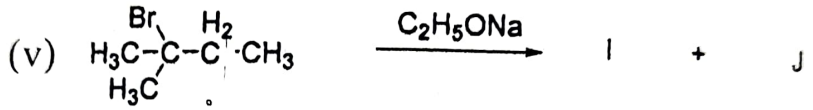
(ii) 

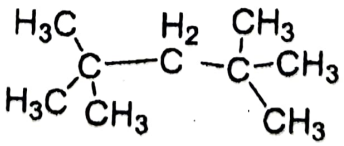
(iii) 

(iv) 

(v) 

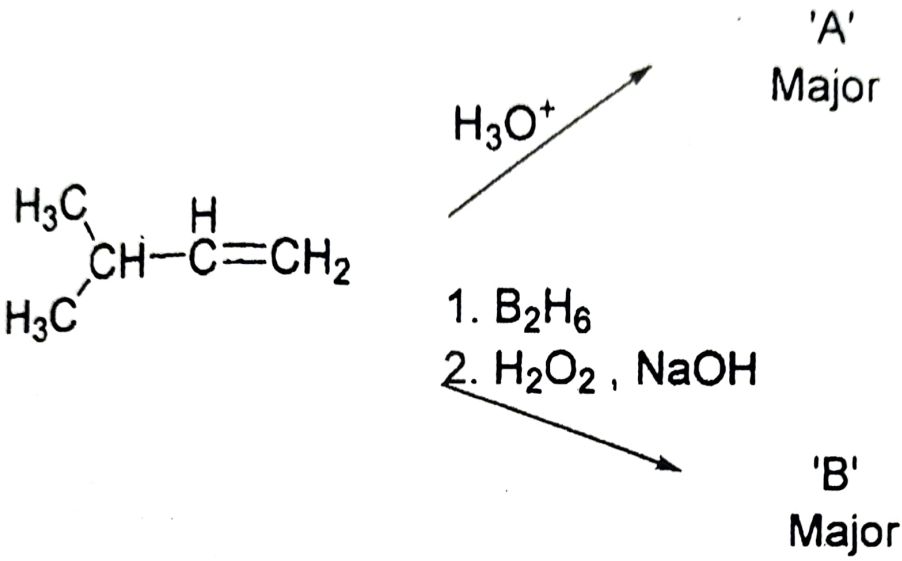
(1.5 marks for each product)

2. (i) Predict the proportion of isomeric products obtained at room temperature from chlorination of the given molecule. The order of reactivity of hydrogen for chlorination is 3° (5.0): 2° (3.8): 1°(1.0)



(ii) Define specific rotation. A solution of compound 'A' (7.14 g in 100 mL) in chloroform was taken in a polarimeter tube (5 cm) and its optical rotation at 25°C is –1.3°. Calculate the specific rotation of compound 'A'.

(iii) Explain the formation of different products, (A) and (B) in the given reactions given below :



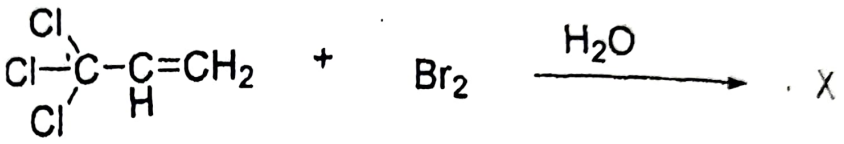
(5,5,5)

(i) 1,3-Butadiene on treating with HBr at low temperature gives 3-bromobut-1-ene (major product), whereas at high temperature, it gives 1-bromobut-2-ene (major product). Explain with mechanism.

(ii) An alkyl halide 'A' (C_4H_9Br) reacts with ale. KOH and gives an alkene, B. Compound B reacts with bromine to give compound 'C' Compound 'C' on treatment with excess of sodamide forms compound 'D'. Further, compound 'D' on

reaction with ammoniacal $AgNO_3$ solution, gives a precipitate (E). Write the structures of A, B, C, D and E.

(iii) Write the structure of 'X' and give the mechanism for its formation.

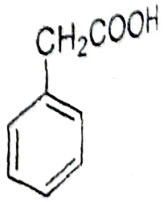


(5,5,5)

4. (i) Draw the Fischer projections formula of threo- and eythro-2,3-butanediol and convert them into corresponding Sawhorse projection formula.

(ii) Draw the possible chair conformations of 1-methylcyclohexane and compare their stability.

(iii) Arrange the following compounds in increasing order of acidity and explain the order.



(5,5,5)

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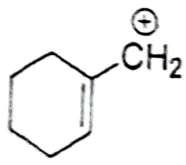
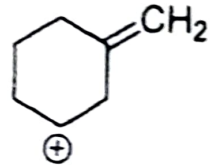
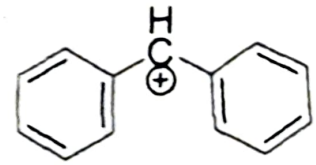
5. (i) Draw the Fischer projection of all the possible stereoisomers of 2,3-dichlorobutan-1,4- dioic acid. Comment on optical activity of each isomer.

(ii) How would you resolve a racemic mixture of a primary amine ($\pm RNH_2$) using the formation of diastereomeric salt?

(iii) Arrange the following carbocations in increasing order of stability and explain the order.







(5,5,5)

(i) Considering the C2-C3 bond rotation in n-butane, draw the potential energy profile for its various conformations.

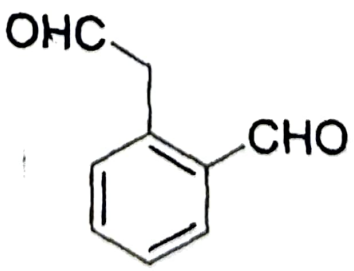
(ii) (a) Why maleic acid has lower melting point than fumaric acid?

(b) Arrange the following compounds in increasing order of their boiling points and explain the order.

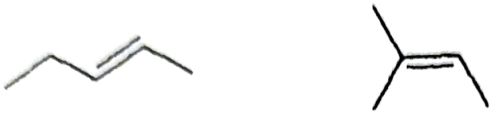
2-methylbutane, 2,2-dimethylpropane and pentane.

(iii) What is allylic halogenation? Give the reason for the products obtained when propene reacts with a) NBS/CCl_4 and b) Br_2 at room temperature. (5,5,5)

7. (i) Find the number of sigma and pi bonds in the given molecule. 8

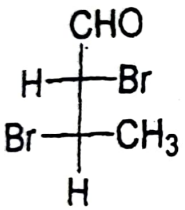


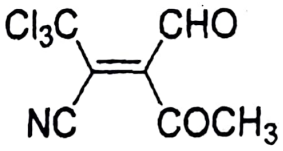
(ii) Which of the following compounds is more stable and why?



(iii) How Corey-House synthesis overcomes the limitation of Wurtz reaction?

(iv) Assign the priority order and find R/S or E/Z configuration for the given molecules:





(3,3,3,6)

8. (i) Write the reaction for hydration of 2-pentyne.

(ii) Give a test to differentiate between 1-butyne and 1-butene.

(iii) Which of the following will exhibit geometrical isomers? Explain by drawing structures.

2-Butene; 2-methyl-2-butene and 2-pentene

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(iv) Differentiate between the following with suitable examples **(any two)** :

(a) Inductive effect and electrometric effect

(b) Relative and absolute configuration

(c) Electrophile and nucleophile (3,3,3)

[This question paper contains 4 printed pages.]

(16) **Your Roll No.** 2024.

Sr. No. of Question Paper : 1621 **G**

Unique Paper Code : 2172011103

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

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

Semester : I

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Use of a scientific calculator and log table is allowed.
3. Attempt **four** questions out of **six**, question number **one** is compulsory.

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

1. Attempt any **Five** of the following :

   (a) An ideal gas is not expected to show any cooling on free expansion. Explain.

   (b) Define the mean free path. Predict mean free path at high vacuum.

   (c) Explain why the viscosity of ethyl alcohol is greater than that of ether.

P.T.O.

(d) Addition of detergent decreases the surface tension of water while NaCl addition increases the surface tension of water. Comment.

(e) Show that van der Waals constant b for a real gas is four times its molecular volume.

(f) Write the formula of average speed, most probable speed, root mean square speed and arrange them in increasing order. (3×5)

2. (a) Derive an expression for the kinetic gas equation, in terms of the mass of a molecule (m), the total number of molecules (N), and the velocity of the molecule (c). (5)

(b) Derive the reduced equation of state for a real gas using the expressions of the critical constants assuming that gas follows van der Waals equation of state. Is this equation applicable to all gases? (5)

(c) For a gas containing 10^{23} gas particles each of mass 10^{-25} kg in a container of volume 10^{-3} m^3. Calculate

(i) The pressure exerted by the gas.

(ii) The total kinetic energy of molecules.

(iii) Temperature of the gas.

Given : Root mean square speed is 10^5 cm s^{-1}. (5)

(a) For oxygen gas at 25 °C and 1 atm pressure calculate.

(i) Mean free path,

(ii) Number of collisions per second per molecule

The collision diameter of oxygen molecule is 361 picometre. (5)

(b) Discuss the effect of height, temperature and molecular mass of the gas on barometric distribution of gases. (5)

(c) (i) Write the mathematical expression for Maxwell's distribution of molecular speeds for a gas explaining briefly the terms involved.

(ii) Derive the expression for the average speed of a gas. (5)

(a) The critical constants for water are 647 K, 22.09 MPa and 0.0566 $dm^3\ mol^{-1}$. Calculate the values of van der Waals constants a, b and R and also explain the abnormal value of R. (5)

(b) Write the van der Waals equation in the virial form and evaluate the second virial coefficient. (5)

(c) Explain the Andrews isotherms for a real gas. Derive the relations between van der Waals constants and critical constants. (5)

5. (a) Define the surface tension of a liquid, give its unit and describe in detail its determination using a stalagmometer. (5)

(b) When a capillary is dipped in a liquid, some liquids rise in the capillary whereas some others fall. Explain the reason behind this phenomenon. What are these liquids called? Give one example of each. Give one example from your daily life where this phenomenon is observed. (5)

(c) Benzene has a density of 0.879 g cm^{-3} and has a surface tension of 0.02888 N m^{-1}. What will be the difference of its heights in two capillaries of radii 0.10 mm and 0.15 mm, respectively? (5)

6. (a) Calculate the pressure exerted by one mole of oxygen gas at 298 K, contained in a container of volume 5 litres, if the gas is a) ideal, b) van der Waals gas. Given a = 5.5 L^2 atm mol^{-1}, b = 63.8 cm^3 mol^{-1}, R = 0.082 L atm K^{-1} mol^{-1}. (5)

(b) How is vapour pressure of a liquid related to its boiling point? Discuss the effect of external pressure and non-volatile impurities on the boiling point of a liquid. (5)

(c) Explain how the viscosity of a liquid varies with temperature ? Support your answer with the mathematical relation between viscosity and temperature. Does viscosity of a gas also show the same variation with temperature? (5)