[This question paper contains 4 printed pages.]

21 Your Roll No..2024

Sr. No. of Question Paper : 4324 **G**

Unique Paper Code : 32171501

Name of the Paper : Organic Chemistry IV : Biomolecules

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 any **6** questions.
3. **All** Questions carry equal marks.

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1. (a) (i) Give the sequence of reactions to establish the pyranose ring size in glucose? (3)

(ii) Draw Fisher projection and Haworth structure of β-D-Fructofuranose. (3)

(b) A pentapeptide, X with empirical composition, Phe-2, Lys, Trp, Tyr was recovered unchanged on treatment with Trypsin. DNFB treatment of X

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followed by hydrolysis gave DNP-Tyr. Partial acid hydrolysis of X gave two tripeptides with the following amino acid composition :

1. Phe,Tyr,Trp

2. Phe, Trp,Lys

Elucidate the sequence of amino acids in X. Give the products of treatment of X with Chymotrypsin. (6.5)

2. (a) Draw the complimentary DNA sequence of the given fragment specifying the direction 5'—ATGC—3'. (4.5)

(b) Draw the structure of glyceryl trilinoleate and calculate its iodine value. (4)

(c) Fructose contains a ketonic group, yet it reduces Tollens' reagent and Fehling's solution. Why? Give the mechanism and name of reaction involved. (4)

3. (a) (i) How is pyruvate converted to ethanol under anaerobic conditions? Name the enzyme and give the reaction involved. (3.5)

(ii) ATP is called the universal currency of cellular energy. Explain giving its hydrolytic pathway. (3)

(b) Give the complete name and structure of

(i) dAMP

(ii) UDP (4)

(c) What are cofactors? Give an example. (2)

4. (a) Give the structure of the disaccharide sucrose. What is its IUPAC name? Account for the observation that it does not reduce Fehling's solution and it does not mutarotate. (3)

(b) Give the mechanism of osazone formation for D-glucose. D-Glucose and D-Fructose give the same osazone. Explain. (3.5)

(c) How would you synthesize the tripeptide, Ala-Gly-Ala using solid phase peptide synthesis. (6)

5. (a) Explain the mechanism of action of chymotrypsin. (6)

(b) What are drying and non-drying oils? Give one example of each type. (4)

(c) What is denaturation of protein? How it is caused? (2.5)

6. (a) An α- D – methylglycoside, X, with molecular formula $C_7H_{14}0_6$, consumes 2 moles of HIO_4 and gives one mole of HCHO. Arrive at possible structure/s of X. (4)

(b) Define genetic code. Give at least three characteristics of genetic code. (4.5)

(c) Differentiate between competitive and non-competitive enzyme inhibition and give examples of each kind. (4)

7. (a) Discuss various steps involved in the glycolysis cycle, giving the names of enzymes and structures of intermediates. (6)

(b) List any two reactions that were not explained by the open chain structure of glucose. How does the cyclic hemiacetal structure of glucose explain them. (4)

(c) Define ω – fatty acids giving suitable example. (2.5)

8. (a) How will you convert :

(i) D-Glucose to D- Arabinose.

(ii) D-Glucose to D-Fructose. (4.5)

(b) List four important characteristic of Watson and Crick model of DNA. (4)

(c) Discuss the 2° structure of proteins. (4)

[This question paper contains 8 printed pages.]

22 **Your Roll No.** 2024

Sr. No. of Question Paper : 4378 **G**

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

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

Section A

(Quantum Chemistry)

1. (a) The uncertainty in a quantity, represented by operator A is given as under,

$$\sigma_A^2 = \langle A^2 \rangle - \langle A \rangle^2$$

For a particle in the ground state of a one-dimensional box having length, L, represented by

$$\psi = \left(\frac{2}{L}\right)^{1/2} \sin\left(\frac{\pi x}{L}\right), \text{ determine } \sigma_x \cdot \sigma_p$$

where x and p represent position and momentum, respectively.

Use standard integral $\int x \sin\left(\frac{\pi x}{L}\right) = \frac{L^2}{4}$ and

$$\int x^2 \sin^2\left(\frac{\pi x}{L}\right) = \left(\frac{L}{2\pi}\right)^3 \left(\frac{4\pi^3}{3} - 2\pi\right).$$

(b) Prove that the functions having different real eigen values for linear momentum operator are orthogonal.

(c) Starting from $\left[\frac{d}{dx}, x\right] = 1$, use the commutator identities to find

(i) $[\hat{x}, \widehat{p_x^2}]$

(ii) $[\hat{x}, \hat{H}]$, $\hat{H}$ is Hamiltonian for a one-particle, three-dimensional system. (4.5,4,4)

2. (a) Demonstrate that the Eigen functions for the particle in a one-dimensional box are orthonormal.

$$\psi(x) = \left(\frac{2}{L}\right)^{1/2} \sin\left(\frac{n\pi x}{L}\right)$$

(b) Write Hamiltonian operators for a particle moving under constant potential 'V' in a (i) one-dimensional box and (ii) three-dimensional box.

(c) As a crude treatment for the π electrons of a conjugated polyene, the π electrons of the conjugated chain are considered as moving in a one-dimensional box across the end to end conjugated chain. Considering 1,3-butadiene as a one-dimensional box of box length, 7.0 Å, calculate the wavelength of light absorbed when a π electron is excited from the highest-occupied to the lowest-vacant level of the molecular electronic ground state. (4.5,4,4)

3. (a) Construct the Hamiltonian operator for Simple Harmonic oscillator and write the Schrodinger equation. What is the zero-point energy of this type of system?

(b) A molecule X has 10 pi electrons and it is assumed to have cubical shape with edge length 10 pm. Give the quantum numbers corresponding to the highest occupied energy levels. Based on the free electron model, calculate the longest wavelength required for transition.

(c) Normalize the following functions :

(i) $f(r) = r \exp(-a r)$ $\quad 0 \leq r \leq \infty$

(ii) $f(\varphi) = N \exp(im\phi)$ $\quad 0 \leq \varphi \leq 2\pi$

(4.5,4,4)

4. (a) Using linear momentum operator $\hat{p}_x$, $\hat{p}_y$ and $\hat{p}_z$, derive angular momentum operators, $\hat{L}_x$, $\hat{L}_y$ and $\hat{L}_z$. Using $\hat{L}_z = -i\frac{h}{2\pi}\left(\frac{d}{d\phi}\right)$ construct the Schrodinger equation dependent on variable φ only. Write a possible solution as an eigen function and determine eigen values.

(b) Using normalized ground state wave function for hydrogen atom

$$\psi(r) = 2\left(\frac{1}{a}\right)^{3/2} \exp\left(\frac{-r}{a}\right)$$

Determine

(i) $\langle E \rangle$

(ii) The radius of maximum radial density distribution of electron

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(c) Why do we need to employ approximate methods to determine solution for multielectron atoms? Explain Variation principle as an approximate method to determine approximate wave function. (4.5,4,4)

Section B

(Molecular Spectroscopy)

5. (a) A molecule AB_2 has the following infra-red and Raman spectra :

Wave number (cm^{-1})	Infrared	Raman
589	Active (PQR)	Inactive
1285	Active (PR)	Active (polarized)
2224	Active (PR)	Active (depolarized)

Giving proper explanation and arrive at the geometry of the molecule. Assign the wavenumbers to specific vibrations.

(b) The intensities of Stokes and anti-Stokes lines are similar in rotational Raman spectra. However, in the vibrational Raman spectra, the Stokes lines are more intense than the anti-Stokes lines. Explain.

(c) Discuss how a simple harmonic oscillator system differs from a homonuclear diatomic molecule undergoing anharmonic oscillations in terms of energy relation and energy vs displacement curve from mean position. (4.5,4,4)

6. (a) Given that the spin quantum numbers of $^{12}C_6$, $^{1}H_1$ and $^{2}D_1$ are zero, half and one, respectively, how many different energy states do these nuclei have in a magnetic field? Which of these atoms will show peak in the NMR spectra?

(b) Draw and discuss, the low and high-resolution NMR spectrum of CH_3CHO showing the peak corresponding to the reference standard TMS.

(c) The pure microwave spectrum for $^{1}H^{35}Cl$ is observed as a series of lines at 20.7, 41.5, 62.0, 83.0, 103.8 cm^{-1}. Evaluate the rotational constant and the internuclear distance for this molecule. (4.5,4,4)

7. (a) What do you understand by the terms, 'singlet' and 'triplet'? On the basis of these terms explain why fluorescence is a rapid phenomenon as compared to phosphorescence.

(b) Explain Larmor precession of a spinning nucleus and derive expression for precessional frequency.

(c) The spacing between the successive lines of Raman rotational spectrum of O_2 molecule is 8B while for H_2 molecule it is 4B (where B is the rotational constant). Explain. (4.5,4,4)

8. (a) What is Fermi Resonance and hot bands in IR spectroscopy.

(b) Write short notes on the following:

(i) Dissociation and Predissociation

(ii) Franck Condon principle (4.5,4+4)

[This question paper contains 4 printed pages.]

23 **Your Roll No.** 2024

Sr. No. of Question Paper : 4430 **G**

Unique Paper Code : 32177902

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

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

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.

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

   (i) A battery that cannot be recharged and must be discarded after single use.

   (ii) Glassware which is preferred for laboratory apparatus that is graduated or needs to be strongly heated.

P.T.O.

(iii) Additives in an emulsion paint formulation which prevent excessive foam formation during manufacturing.

(iv) Nutrients which are required in very small amounts by plants.

(v) Urea is an example of a _____ fertilizer.

(vi) The process of surface hardening caused due to the diffusion of boron into the base metal or alloy is called _____

(vii) Safety glass has a layer of _____ sandwiched between two layers of glass.

(b) Distinguish between the following :

(i) Physical Vapor Deposition and Chemical Vapor Deposition.

(ii) Wet and Dry process for the manufacture of cement.

(c) Write short notes on :

(i) Nitrogenous Fertilizers

(ii) Fire Retardant Paints (7,4,4)

2. (a) What are the various components of a battery? Differentiate between primary and secondary battery.

(b) Write the discharging and charging reactions of a lead acid battery and explain how the battery works.

(c) How do photons initiate the reactions in a solar cell? Describe the working of a solar cell with a diagrammatic representation. (4,4,4)

3. (a) How does urea function as an effective fertilizer for plants? Give one method for the manufacture of urea.

(b) How is ammonium nitrate fertilizer prepared? What are the drawbacks of using ammonium nitrate fertilizer?

(c) Define alloy steel? Discuss the effects of Nickel, Chromium and Manganese on steel. (4,4,4)

4. (a) What are composite materials? Discuss their importance as engineered materials giving examples.

(b) Write down the uses of ceramic products. How is glazing of ceramics done?

(c) Discuss the characteristics and applications of the following :

(i) Soda lime glass

(ii) Borosilicate glass (4,4,4)

5. (a) What are carbon nanotubes? Describe the formation, characteristics, and applications of carbon nanotubes.

(b) What are superconducting oxides? Explain giving examples.

(c) Discuss the various types of cast iron. Write their composition and applications. (4,4,4)

6. (a) Write different constituents of a paint. What are the requisites of a good paint?

(b) What is the purpose of applying surface coatings to objects? Discuss the process of galvanization.

(c) Explain electroless plating with an example. What are the advantages of electroless plating? (4,4,4)

7. (a) Describe the steps involved in the manufacture of glass and give the reactions involved.

(b) Explain the process of setting and hardening of cement. Give the reactions involved.

(c) What are zero and two-dimensional nanomaterials? Explain giving examples. (4,4,4)

8. (a) What is CAN? Give the general steps involved in the manufacture of this fertilizer.

(b) What is the significance of pigment in a paint? Define Pigment Volume Concentration (PVC) and Critical Pigment Volume Concentration (CPVC).

(c) What is a fuel cell? Explain the working of a fuel cell. (4,4,4)