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3 (Sem-5/CBCS) CHE HC 1

2023

## CHEMISTRY

(Honours Core)

Paper : CHE-HC- 5016

**(Organic Chemistry-IV)**

Full Marks : 60

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

1. Answer the following questions :  $1 \times 7 = 7$

(a) Nucleoside + Phosphate = ?

(b) A Nucleotide is represented as \_\_\_\_\_.

(c) Except \_\_\_\_\_ all  $\alpha$ -amino acid are optically active.

(d)  $\overset{+}{N}H_3 - CH_2 - CO - NH - CH_2 - COO^-$

It is a dipeptide. Name the component amino acid.

Contd.

(e) What causes the disease sickle cell anaemia?

(f) Give *one* example of oxidative enzymes.

(g) Give an example of simple triglyceride.

2. Answer the following questions:  $2 \times 4 = 8$

(a) Comment on the statement that ATP acts as a universal currency of free energy in biological synthesis.

(b) What products would be formed when a nucleotide from DNA - containing Thymine is hydrolysed?

(c) What happens when alanine is treated with nitrous acid? Give reaction.

(d) What do you mean by functional group interchange (FGI) and functional group addition?

3. Answer *any three* of the following:

$5 \times 3 = 15$

(a) What are the names of ribonucleosides of the *five* different bases, and also write the name of the bases?

(b) Draw a structure of nucleotide by showing phosphodiester linkage between 5' and 3' carbon atoms of the pentose sugar.

(c) Give the reaction of phthalimidomalonic ester synthesis for amino acid.

(d) Describe the following:

(i) Zwitterion structure of amino acid

(ii) Isoelectric point of amino acid

(e) What are enzymes and co-enzymes? Give example.

4. Answer *any three* of the following questions:  $10 \times 3 = 30$

(i) (a) What is the difference between oils and fats? 5

(b) What do you mean by acid value and hardening of oils? 5

(ii) Write notes of the following:  $3 + 3 + 4 = 10$

(a) Oxidation of food stuffs and cellular energy

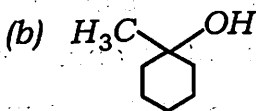
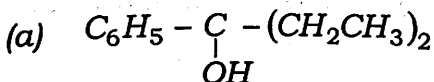
(b) Catabolism and anabolism

(c) Metabolic path ways of Carbohydrates

(iii) (a) How malaria is caused? Name some useful drugs which are employed as antimalarials. How pamaquine is synthesised? 5

(b) Describe the synthesis of Chloramphenicol. 5

(iv) Give the retrosynthesis of 5+5=10



from Grignard reagent.

(v) (a) What is meant by nucleosides and nucleotides? Give one example of each. 3

(b) Write down the structure of nucleosides which is present only in RNA. 3

(c) What are the functions of nucleic acids in the human body? 4

(vi) (a) Amino acids are weaker acids than carboxylic acids. Explain why? 2

(b) What do you mean by N-terminal and C-terminal residue in proteins? How are these identified? 4

(c) Explain the biological importance of proteins. 4

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3 (Sem-5/CBCS) CHE HC 2

2023

**CHEMISTRY**  
(Honours Core)

Paper : CHE-HC-5026

(Physical Chemistry-V)

Full Marks : 60

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

1. Answer the following as directed:  $1 \times 7 = 7$

(a) State whether the following statement is True or False:

For the particle in the box, the maximum probability density for every stationary state wave-function is at the midpoint of the box.

Contd.

- (b) Show that  $\sin nx$ . ( $n$  is an integer) is an eigenfunction of the operator  $\frac{d^2}{dx^2}$  and find the eigenvalue.
- (c) Derive the term symbol for the ground state configuration of  $Na$ .
- (d) State which of the following are microwave active and why:  
 $CO_2$ ,  $OCS$ ,  $HF$ ,  $N_2$
- (e) The ionization energy of a molecule is  $10 \text{ eV}$ . Calculate the wavelength of the radiation that ionize the molecule.  
 ( $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$ )
- (f) What do you mean by inter system crossing?
- (g) What are photoinhibitors?

2. Answer the following questions:  $2 \times 4 = 8$

- (a) Show that the wave function for a particle in one-dimensional box of length  $a$ , where the potential energy is zero, is not an eigenfunction of the linear momentum operator in one dimension.

(b) The functions  $\psi_1 = \left(\frac{1}{\pi}\right)^{1/2} \cos x$  and

$\psi_2 = \left(\frac{1}{\pi}\right)^{1/2} \sin x$  are defined in the

interval  $x=0$  to  $x=2\pi$ . Examine if the functions are orthogonal to each other.

- (c) Write how the population of states affects the intensity of spectral line.
- (d) Microwave causes molecules to rotate more energetically. A molecule absorbs microwave photon of wavelength  $20 \text{ cm}$ . Calculate the energy difference between the two rotational levels in joule.

3. Answer **any three** questions:

- (a) Show that the energy levels of a harmonic oscillator are evenly spaced and it has an energy greater than zero even in its lowest state. 5

(b) (i) Define complementary observable with one example. 1+1=2

(ii) Show that if two linear operators  $A$  and  $B$  have the same complete set of eigenfunctions, then  $[\hat{A}, \hat{B}] = 0$ . 3

(c) The first line in the pure rotational spectrum of  $^{12}\text{C}^{16}\text{O}$  is observed at  $3.8424 \text{ cm}^{-1}$ . Calculate bond length considering the molecule as rigid rotator. Does the bond length of a real molecule change as rotational energy increases? If yes, how? 4+1=5

(d) (i) Discuss in brief what do you mean by hot bands: 2

(ii) Find the normal vibrational modes of  $\text{CO}_2$ . Explain which are IR-active and which are not. 3

(e) Write the mechanism of the  $\text{H}_2\text{-Cl}_2$  photochemical reaction. Prove that the rate of formation of  $\text{HCl}$  is directly proportional to the intensity of the absorbed radiation. 2+3=5

4. Answer any three questions.

(a) (i) Write down the Hamiltonian operator for the hydrogen atom and show that the maximum radial probability density for the 1s state of H-atom occurs at a distance equal to Bohr radius. 2+3=5

(ii) Which of the following functions are eigenfunctions of  $\frac{d^2}{dx^2}$  ?

(i)  $\sin 2x$

(ii)  $4\cos 3x$

(iii)  $5x^2$

(iv)  $\frac{1}{x}$

(v)  $5e^{-3x}$

Determine the eigenvalue of each function. 5

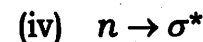
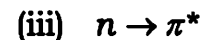
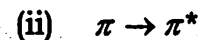
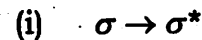
- (b) (i) Derive expression for the total energy of a particle in a three-dimensional box. Explain the concept of degeneracy. 4+2=6
- (ii) Taking the example of  $H_2^+$ , explain how the potential energy diagram can be constructed. What information regarding characterization of a bond can be obtained from this diagram? 3+1=4
- (c) (i) Considering the diatomic molecule to be a rigid rotator, deduce an expression in wave number unit for the energy required for rotational transition to take place. Explain how the spectrum will differ if the molecule is considered to be a non-rigid rotator. 3+2=5
- (ii) The force constant of CO is  $1840 Nm^{-1}$ . Calculate oscillation frequency and wave number in  $cm^{-1}$ . 3
- (iii) Explain with examples the terms chromophore and auxochrome. 2

- (d) (i) Show that the Raman lines in the pure rotational Raman spectrum of a diatomic molecule appear at wave number

$$\bar{\nu} = \bar{\nu}_0 \pm 2B(2J+3)$$

where  $\bar{\nu}_0$  is the wave number of the Rayleigh line. Draw the schematic diagram to show the Stokes lines and the Anti-Stokes lines. 4+1=5

- (ii) Show diagrammatically the relative frequencies of following electronic transitions :



Discuss the effect of polarity of the solvent on the above transitions. 3+2=5

- (e) (i) Discuss briefly the molecular orbital treatment of  $BeH_2$  and  $H_2O$  molecules. 5

(ii)  $\text{HCl}$  molecule has the fundamental frequency  $2990\text{cm}^{-1}$ . The anharmonicity constant is  $0.019$ . The depth of the potential well is  $43000\text{cm}^{-1}$ . Calculate the dissociation energy in  $\text{kJ mol}^{-1}$ .

3

(iii) Write short note on :

2

Rule of Mutual Exclusion

(f) (i) With the help of Jablonski diagram, explain all the photophysical processes that an electronically excited molecule may undergo. Give two major differences between fluorescence and phosphorescence.

3+2=5

(ii) A substance was exposed to a radiation of wavelength  $420\text{nm}$  for a definite period of time when an amount of  $10.5\text{J}$  of energy was absorbed. During this time  $1.8 \times 10^{-5}\text{mol}$  of the substance was found to decompose. Calculate quantum efficiency.

3

(iii) What is a photostationary state? Explain with example.

2