

**P.G. DIPLOMA IN ANALYTICAL CHEMISTRY
(PGDAC)**

Term-End Examination

June, 2022

MCH-003 : SPECTROSCOPIC METHODS

Time : 3 hours

Maximum Marks : 75

Note : Answer any **five** questions. All the questions carry equal marks.

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

- (a) Explain the difference between line spectrum and band spectrum. Draw a schematic diagram of emission band spectrum of a molecule. 5
- (b) Draw a generalised molecular orbital energy level diagram and show all the possible transitions in an organic compound. Explain all the transitions. 5
- (c) Discuss the applications of fluorescence and phosphorescence. 5
- (d) Explain the spectral line width schematically. Write the reasons of line broadening. 5
- (e) Draw a schematic diagram of ultrasonic nebulizer and explain its principle. 5

2. (a) Define wavelength, wave number, frequency and energy and mention their units. Calculate energy for wavelength of 500 nm.
($h = 6.63 \times 10^{-34}$ Js, $c = 3 \times 10^8$ ms⁻¹) 5
- (b) Explain the stretching and bending modes of vibrations for typical AB₂ molecules. How would these differ in CO₂ and SO₂ molecules? 5
- (c) Draw a schematic diagram of a double beam UV-visible spectrophotometer. Discuss its advantages over single beam spectrophotometer. 5
3. (a) Explain the Particle theory of Raman Effect, with the help of schematic representation of the energy changes associated with the excitation, Rayleigh scattering and Raman scattering. 5
- (b) Differentiate between phosphorescence and fluorescence. Draw Jablonski diagram showing these two phenomena. 5
- (c) State Franck-Condon principle and explain its implications. Briefly discuss the non-radiative deactivation of excited state of molecule. 5

4. (a) Explain the relationship between structure of molecules and their characteristic fluorescence. Explain this phenomenon in pyridine molecule. 5
- (b) Define quantum yield, with the help of mathematical expression. 5
- (c) Predict the important spectral signals expected in the IR and ^1H NMR of ethyl ethanoate or benzoic acid. 5
5. (a) What are the characteristics of atomic spectra ? Briefly explain them, with the help of a typical spectrum. 5
- (b) Draw schematic structure of flame showing various zones. Explain all the reactions in flames. 5
- (c) Write the important applications of AAS in the area of environmental analysis. 5
6. (a) What is the origin of atomic fluorescence ? List the various types of atomic fluorescence transitions. 5
- (b) Explain atomisers. Write the disadvantages of flame atomisers. 5
- (c) Differentiate between single beam and double beam flame atomic absorption spectrophotometer. 5

7. (a) Explain the role of organic solvents in the preparation of solution for atomic absorption spectrophotometry. 5
- (b) Describe the principle of atomic emission spectrometry. Discuss the role of plasma sources in AES. 5
- (c) Draw a schematic layout of different components of an ICP-AES spectrometer and discuss the role of monochromators in ICP-AES. 5
8. (a) Define nuclear magnetic moment in terms of spin angular momentum (I) and nuclear Bohr Magneton. Which of the following nuclei are NMR active and why? 5
- ^2D , ^{13}C , ^{18}O , ^{31}P
- (b) Define spin-spin coupling. Write down possible spin orientation of two protons in $-\text{CH}_2$ group. 5
- (c) Explain the theory of mass spectrometry. Define isotopic peaks and explain it, with the help of mass spectrum of CH_3OH . 5
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