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MCH–003

POST GRADUATE DIPLOMA IN ANALYTICAL CHEMISTRY (PGDAC)

Term-End Examination

December, 2024

MCH-003 : SPECTROSCOPIC METHODS

Time : 3 Hours *Maximum Marks : 75*

Note : *(i) Answer any* ***five*** *questions.*

(ii) All questions carry equal marks.

1. Answer any *five* of the following :

   (a) Explain the origin of fundamental vibration, first overtone and second overtone with an illustration. 3

   (b) What is the role of H_2O_2 in the analysis of glucose by fluorimetry ? Explain briefly. 3

   (c) What is a nebuliser ? Name any *two* nebulisation methods. 3

(d) Write any *three* fuel-oxidant combinations commonly used in atomic absorption spectrometry. Also mention their flame temperatures. 3

(e) Which of the following nuclei will be NMR active ? 3

^{12}C, ^{13}C, ^{18}O, ^{19}F, ^{31}P, ^{32}S

(f) Predict the fragments obtained in CH_3CH_3 and $C_6H_5CH_3$. Where would the m/z peak be obtained ? 3

2. (a) Explain and differentiate between atomic absorption and molecular absorption. Why is a band spectrum observed in molecular absorption spectra ? 5

(b) What is the origin of UV-Vis spectrum ? Explain $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions with the help of MO diagram in organic compounds. 5

(c) Name *three* types of detectors used in UV-Vis spectrophotometers. Discuss the salient features of any *one* of these with illustration. 5

3. (a) Explain various vibrational modes for CO_2 molecule with illustration. Calculate the number of vibrational degrees of freedom for CH_4. 5

   (b) Name essential components of a Raman spectrometer. Draw a schematic diagram of FT-Raman spectrometer. Name any *two* laser sources for the same. 5

   (c) State the Franck-Condon's principle. Explain how excited state gets deactivated by different processes. 5

4. (a) Name the *four* factors that affect fluorescence in a molecule. Discuss any *one* of these briefly. 5

   (b) Describe sampling and recording procedure for measuring phosphorescence of a sample. Draw the sample assembly schematically. 5

   (c) Discuss the fluorimetric method for the determination of SO_2 in an air sample. Compare this method with chemiluminescence method available as automated analyzers. 5

5. (a) Define bioluminescence. What is the origin of glow with emission of light ? Briefly describe its applications in medical field of research. 5

(b) How are atomic spectroscopic methods classified ? Explain any *one* of these methods briefly. 5

(c) Name the processes which occur when a sample is introduced in the flame. Write salient features of each of these with equations. 5

6. (a) Discuss various types of interferences encountered in quantitative analysis by flame photometry. Also mention, how these can be suppressed. 5

(b) Discuss the merits and limitations of atomic fluorescence spectrometry. 5

(c) Explain the common types of atomic fluorescence transitions illustrating each one with schematic representation. 5

7. (a) Why graphite furnance atomisation is preferred over flame atomisation method ? Discuss with schematic diagram of electrically heated graphite furnace. 5

(b) Compare performance of single beam and double beam atomic absorption spectrophotometers. Write essential features of modern AAS. 5

(c) What are the essential components of plasma based atomic emission spectrometer ? Draw a schematic layout of ICP-AES spectrometer. 5

8. (a) What is Pascal's triangle ? Explain its usefulness in the prediction of intensity of split lines in NMR spectrum. 5

(b) Define the Index of Hydrogen Deficiency (IHD). Calculate IHD for C_4H_9N and predict if the molecule has ring structure or unsaturation. 3

(c) An organic compound with molecular formula $C_8H_8O_2$ shows the following spectral characteristics :

IR : Intense band at 1700 cm^{-1} and a broad band at 3000 cm^{-1}

NMR : A triplet at $\delta = 2.3$

A multiplet at $\delta = 7.4 - 7.9$

A singlet at $\delta = 10.5$

Mass : m/z = 45, 91, 119 and 136.

Identify the compound by interpreting the spectra. 7

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