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MCH-003

P.G. DIPLOMA IN ANALYTICAL CHEMISTRY (PGDAC)

Term-End Examination

00764 **December, 2016**

MCH-003 : SPECTROSCOPIC METHODS

Time : 3 hours *Maximum Marks : 75*

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

1. Answer any ***five*** of the following : *5×3=15*

   (a) What is plane polarised light ? How is it obtained ?

   (b) Molecules show broad spectral bands whereas atoms give line spectra. Explain.

   (c) What are the different types of transitions involved in uv-visible, infrared and microwave spectral techniques ?

   (d) Draw a labelled sketch of hollow cathode lamp and explain its use in AAS.

   (e) Explain the variation in the position of the OH signal in the NMR spectrum of phenol as a function of concentration.

   (f) Write the various factors affecting fluorescence.

2. (a) Draw a generalised molecular orbital energy level diagram showing possible transitions in organic compounds. Indicate various transitions observed for acetone in the diagram. 5

(b) Define molar absorbance and transmittance and explain the relationship between the two. Calculate the transmittance of a solution having A = 0·2. 5

(c) What are the advantages of FT-IR spectrometer over dispersive IR spectrometer ? 5

3. (a) Explain various types of stretching and bending vibrations by considering suitable examples of AB_2-type molecule. 5

(b) A $6{\cdot}5 \times 10^{-5}$ M solution of copper complex taken in a 1 cm cuvette showed the absorbance of 0·85 at λ_{max} = 580 nm. Another solution of unknown concentration measured at the same λ_{max} showed the absorbance of 0·68. Calculate the concentration of the unknown solution. 5

(c) Explain the nature of excitation and emission fluorescence spectra of 9-methylanthracene. Why does fluorescence occur at longer wavelengths than the absorption ? 5

4. (a) Explain fluorescence quenching and write the Stern-Volmer equation for it. Define quantum yield. 5

(b) Describe the applications of fluorimetry in the analysis of NO – NO_2 as atmospheric pollutants. 5

(c) Draw a schematic layout of fluorimeter. Write the sources and detectors commonly used in the fluorimeters. 5

5. (a) Explain the characteristics of atomic spectrum in terms of position, intensity and spectral line width of signal. 5

(b) Define flame. Explain how different combinations of fuel gases and oxidants give different flame temperatures. 5

(c) Explain the basic principle of atomic fluorescence spectrometry. Write down the equation relating fluorescence intensity with concentration and draw the calibration plot. 5

6. (a) Discuss the merits and limitations of atomic fluorescence spectrometric method in quantitative analysis. 5

(b) Discuss briefly GFAAS. Explain how the signal obtained in GFAAS is different from that obtained in flame AAS. 5

(c) Explain various types of interferences in atomic absorption spectrophotometry. How can the interference of phosphate be eliminated or minimized in the determination of calcium ? 5

7. (a) In what respects is Atomic Emission Spectrometry (AES) different from AAS. Describe in brief, the AES based plasma sources. *5*

(b) State three groups in which all nuclei may be classified on the basis of spin quantum number. Explain why ^{1}H, ^{13}C, ^{19}F show NMR whereas ^{12}C and ^{16}O do not. *5*

(c) List all the essential components of mass spectrometer. Draw a schematic sketch of magnetic sector mass analyzer. *5*

8. (a) Define Index of Hydrogen Deficiency (IHD). Calculate IHD for C_7H_7NO and predict if it is unsaturated. *3*

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

(i) Mass spectrum shows molecular ion peak at 136 and other fragmentation peaks at m/z 119, 91 and 45.

(ii) Electronic spectrum shows an intense band at 230 nm.

(iii) Infrared spectrum shows an intense peak at 1700 cm^{-1} and a broad band at 3000 cm^{-1}.

(iv) NMR spectrum shows a triplet at about δ 2·3, a multiplet at δ 7·4 – 7·9. Also a singlet is observed at δ 10·5.

Interpret all the observations by assigning all the spectral peaks. Identify the compound and assign the structure. *12*