P.G. DIPLOMA IN ANALYTICAL CHEMISTRY (PGDAC)

00702

Term-End Examination

December, 2010

MCH-003 : SPECTROSCOPIC METHODS

Time : 3 hours *Maximum Marks : 75*

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

You may use the following values of the physical constants :

Planck's constant $h = 6.626 \times 10^{-34}$ Js

Boltzman constant, $k = 1.381 \times 10^{-13}$ Jk^{-1}

Velocity of light, $c = 3.0 \times 10^{8}$ ms^{-1}

1. Answer ***any five*** of the following : **3x5=15**

   (a) Define monochromatic radiation and name the device used for obtaining a monochromatic radiation from a polychromatic radiation.

   (b) What are overtones ? How are the frequencies of the first and second overtones related to the fundamental frequency ?

(c) The visible spectra for the lanthanide ions consist of narrow bonds whereas for the transition metal ions these are broad. Explain.

(d) What is meant by self quenching of fluorescence ? How does it depend on the concentration of the absorbing species ?

(e) What is meant by source resolution in atomic absorption spectrophotometry ? How is it achieved ?

(f) Argon gas is used as a plasma gas source. What makes it a good choice for the same ?

(g) What is meant by isotopic peaks in the mass spectrum ? What is their importance ?

(h) Explain the origin of stokes and antistokes lines in Raman spectrum.

2. (a) One of the characteristic absorption by gaseous sodium atom occurs at 589 nm in the yellow region of the spectrum. The absorption of radiation causes the excitation of an electron from 3*s* energy level to one of the 3*p* states. Compute, **5x3=15**

(i) The energy of the radiation absorbed.

(ii) The population of the 3*p* level with respect to the 3*s* energy level in the sodium atom at 600 K.

(b) Explain the internal standard method of quantitative analysis using flame photometry.

(c) Define bioluminescence and explain the phenomenon of bioluminescence with the help of an example.

3. (a) Explain the principle of revolving can shutter system used for simultaneous measurement of fluorescence and phosphorescence. **5x3=15**

(b) Describe the structure of a premixed flame with the help of an illustrated diagram.

(c) Describe the mechanisms of stokes direct line fluorescence and resonance fluorescence. In what way are the measurement based on direct line fluorescence better than the based on resonance fluorescence ?

4. (a) Write ***any five*** characteristics which can differentiate atomic absorption spectrometry from atomic emission spectrometry. **5x3=15**

(b) Describe the working of a double focussing mass analyser.

(c) Explain different relaxation mechanisms that contribute to the relaxation of nuclear spins in the excited state.

5. (a) Calculate the ratio of number of nuclei in the upper energy state to the number in the lower energy state for a 13_C nucleus in the presence of a field of 2.3T at 300K. Given that $g_N = 1.405$ for 13_C and $\mu_N = 5.05 \times 10^{-27}\ JT^{-1}$. **5x3=15**

(b) Explain the principle of a polychromator used in ICP-AES. How is it better than a sequential atomic emission spectrometer ?

(c) The mass spectrum of butanoic acid (Molar mass = 88 g mol^{-1}) gives a characteristic peak at m/t = 60. Justify the same.

6. (a) Why do we need to enhance the intensities of signals in Raman spectrum ? Explain any one method of enhancement of Raman spectral intensities. **5**

(b) Deduce the structure of an organic compound (Molecular formula C_3H_6O) on the basis of the following spectral information : **10**

Mass : Molecular ion peak at m/t = 58, other important fragments at m/t = 15 and 43 ; The peak at m/t = 43 being the base peak.

IR : A strong signal at around 1700 cm^{-1} besides other signals.

NMR: A signal at δ = 2.2 ppm.

7. (a) Describe the working of a Hollow Cathode lamp used in atomic fluorescence spectrometry. 5x3=15

(b) Draw a schematic diagram representing different components of a dispersive IR instrument.

(c) Calculate the population ratio of first excited state to the ground state at 727°C, if the gap between the first excited state and the ground state is 500 nm.

8. Write short notes on ***any three*** of the following : 5x3=15

(a) Larmour precession

(b) Wear metal analysis

(c) Mutual exclusion principle

(d) Beer - Lambert's law