



Uva Wellassa University of Sri Lanka  
Faculty of Science and Technology  
Department of Science and Technology  
300 level 2<sup>nd</sup> Semester Examination – Dec/Jan 2018  
MRT 362-3 Analytical Techniques and Instrumentation



2.

i. Draw a schematic diagram of Gas Chromatography-Mass Spectroscopy (Label the components of the instrument) [30 Marks]

ii. Van-Deemter equation is shown below. Define the terms of equation.

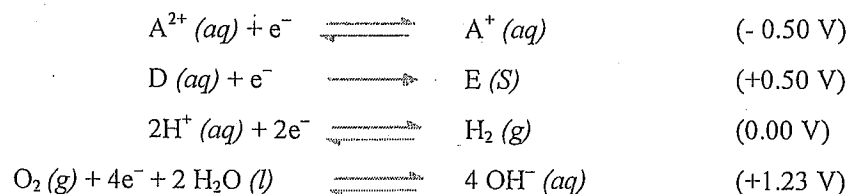
$$H = A + B/\mu + C \mu$$

Write a brief explanation about factors effect on the flow rate when you program for a sample. (Less than 200 words) [30 Marks]

iii.

a. You are planning to do a cyclic voltammetric analysis for an aqueous sample. Write the names of three electrodes which re used in this analysis and give the real examples for these three electrodes. [10 Marks]

b. Following reduction potentials are with respect to Standard Hydrogen Electrodes (SHE). A, D and E indicate Chemical Species (not a standard notations).



Write a sketch of the each CVs (2 Plots of the Current vs Voltage with respect to SHE) you are expected to observe for the Nitrogen purged aqueous solution of  $A^{2+}$  and the

aqueous solution of D (scan range is from -1.00 V to +1.00 V respect to SHE)

[30 Marks]

Important points

Think you are using the electrodes mention in your previous answer,

If the gases are existed or produced during the scanning, they leave out immediately (due to purging of Nitrogen)

"E" solid cannot electrochemically convert back to D.

other chemical species are electrochemically oxidize and reduce at the conditions of your experiment.

3.

i. What is meant by the word " Spectroscopic Techniques"? (use less than 30 words)

[08 Marks]

ii.

a. What are the major relevant series of radiations for Nucleus, Electronic, Vibrational and Rotational Energies of atoms and molecules? [10 Marks]

b. Draw a diagram of a single beam spectrophotometer and label all the components.

[20 Marks]

c. Write down the Beer Lambert law and explain all the terms

[06 Marks]

d. Absorbance = - log (transmittance)

Calculate the molar absorptivity of a  $1.00 \times 10^{-4} \text{ mol dm}^{-3}$  solution, which has transmit 62% of incident light, when the path length is 2.5 cm.

[14 Marks]

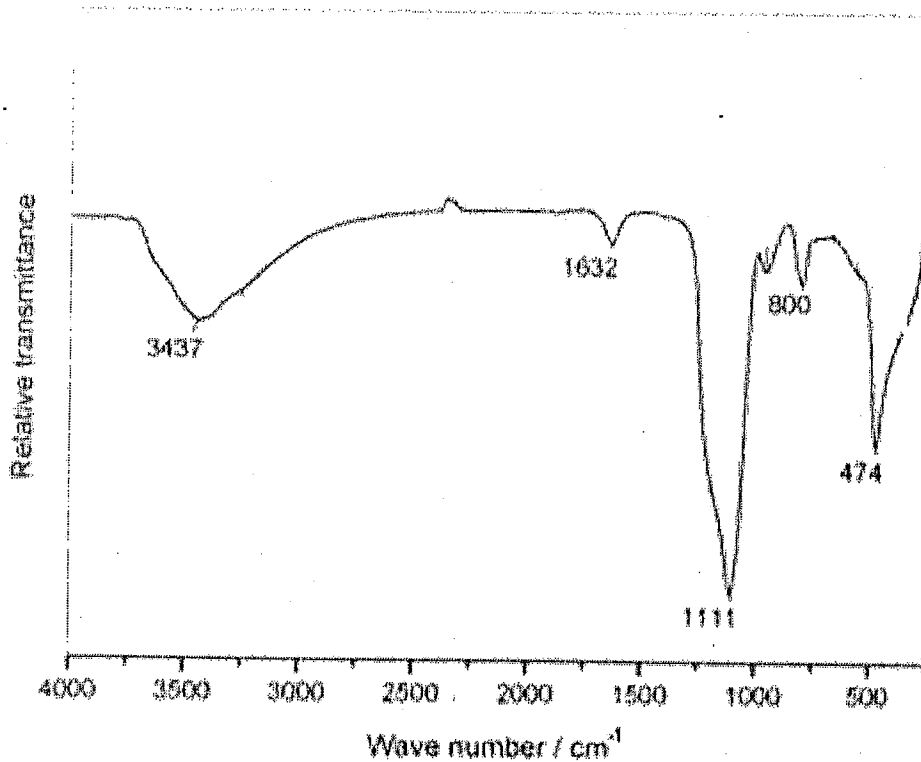
e. Write down three molecular vibrational modes and explain them using a simple sketch

[12 Marks]

f. FTIR spectrum of a ciratain sample is given below. Identify the compound present in the sample out of the compounds given below.

(Quarts, Montmorillonite or Clay Minerals, Iron Oxide, Calcium Carbonate, Any Gas or Organic Fatty Acid. It may be dry or wet)

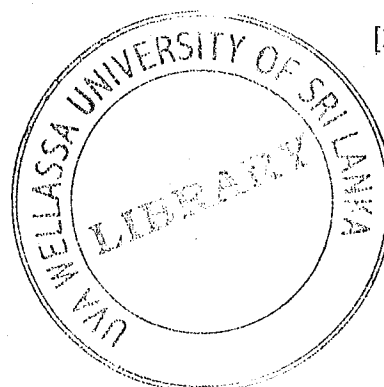
[30 Marks]



Vibrations	Characteristic Absorption(s) /cm <sup>-1</sup>
Si-O-Si asymmetric stretching vibrations	~ 1100 - 1120
O-Si-O bending vibrations	~470
Si-O-Si symmetric stretching vibrations	~800
stretching vibration of HO	3200-3600
Alkenyl C-H Stretch	3010 - 3100
C=O Stretch	1640-1730
Alkynyl C-H Stretch	~3300
Bending vibration of H <sub>2</sub> O	~1630 cm <sup>-1</sup>
<i>stretching Al-O</i>	~855
<i>stretching Fe-O</i>	~600

4.

- i. Explain the working principles of atomic absorption and atomic emission spectrometers. (No need to explain mechanism of monochromator, detector, etc.) [30 Marks]
- ii. What are the technical differences of atomic absorption and atomic emission spectrometers? [20 Marks]
- iii. Contrast and compare flame and electro thermal atomization process (do not describe type of different atomizers) [20 Marks]



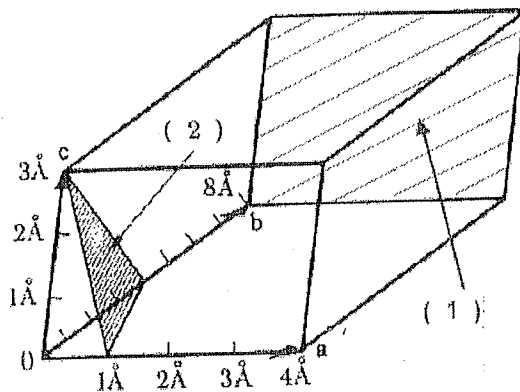
iv. Describe how energy is transferred from radio frequency generator to plasma in inductively coupled plasma. [30 Marks]

5.

i. Calculate the d spacing of (020) planes in a cubic lattice with a unit cell parameter of  $6.8 \text{ \AA}$ . [20 marks]

ii. You can predict the lattice type (unit cell centring) by analysing the observed hkl values in a given XRD pattern. How do you distinguish four lattice types by those observations? [20 marks]

iii. Determine the miller indices of the two planes shown in the figure below. [20 Marks]



iv. In an XRF spectrum, there can be several types of peaks in addition to elemental peaks. Write four types of such peaks. [20 Marks]

v. Write four different applications of XRF. [20 Marks]

6.

i. Rayleigh criterion explains the relationship between the wavelength of the radiation use to observe an object and the resolution of the image. Write the Rayleigh criterion equation and define the terms. [10 marks]

ii. Write three advantages of the use of electrons in imaging processes. [30 marks]

iii. What did you mean by "secondary electrons" and "back scattered electrons" in SEM? [20 marks]

iv. TEM can be applied in imaging process as well as diffraction pattern analysis. Draw the schematic diagrams to differentiate the projection operation of two processes. [40 marks]