UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR

FIRST SEMESTER EXAMINATION

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SCH 301: THEORY OF SPECTROSCOPY

DATE: DECEMBER 8, 2016 **TIME: 2:00-4:00PM**

INSTRUCTIONS:

Answer question ONE and any other TWO questions

Some useful Data

Avogadro constant, $N_A = 6.023x10^{23}mol^{-1}$ Plank's constant, h=$6.626x10^{-34}Js$

Speed of light, $c = 2.9979x\ 10^{8}m/s$ *or* $2.9979\ x10^{10}cm/s$

QUESTION ONE (30 MARKS)

a) Identify the first three regions in the electromagnetic spectrum. (3 marks)

b) Using an energy level diagram briefly explain absorption of electromagnetic radiation. (4 marks)

c) Molecules are classified into four classes base on their symmetry identify the four classes. (4 marks)

d) Determine the number of vibrational modes in;

i) CO_2 (2 marks)

ii) HCl (2 marks)

e) TMS in used as a standard in NMR. Identify three advantages that it has over other standards. (3 marks)

f) The HCl spectrum has an intense absorption line at 2886cm^{-1}, a weak line at 5668cm^{-1} and a very weak line at 8347cm^{-1}. Determine the equilibrium frequency of the molecule. (4 marks)

g) Write an equation relating frequency and wavelength. (2 marks)

h) Determine the energy of a radiation whose wavelength is 945nm (4 marks)

i) Write the mathematical expression of Beer-Lambart law. (2 marks)

QUESTION TWO

a) Explain the three factors that affect intensities of spectral transitions. (9 marks)

b) Explain three factors that affect the width of spectral lines. (9 marks)

c) Identify two groups that that absorb radiation in the IR region. (2 marks)

QUESTION THREE

a) i) What is stark effect? (1 mark)

ii) Explain two major advantages of the stark effect. (6 marks)

b) i) Using energy level diagram explain the term stimulated emission (4 marks)

ii) Explain the three qualities of radiation emitted under stimulation. (9 marks)

QUESTION FOUR

a) The wavelength of the radiation absorbed during a particular spectroscopic transition is observed to be 1.0 x 10^{-5} m.

i) Express thin in frequency (Hz) (3 marks)

ii) Convert the frequency to wave number λ^{-1}. (2 marks)

iii) Calculate the energy change during the transition in both joules per molecule and joules per mole. (5 marks)

b) i) Determine the number of vibrational modes in a water molecule. (2 marks)

ii) Name the vibrational modes in b(i) above and sketch them. (6 marks)

c) Given that $w = \frac{1}{2\pi}\sqrt{\frac{k}{H}}$ H_2 show that $w = \frac{1}{2\pi c}\sqrt{\frac{k}{H}}$ cm^{-1} for an elastic bond. (2 marks)

QUESTION FIVE

a) Given that the rotational levels of linear molecules are given by

$\varepsilon_j = \beta j(j+1)cm^{-1}$ for (j = 0,1,2.....)

Show that the corresponding spectral line wave numbers are

$\bar{v}s = \bar{v}ex \mp B(4j + 6)cm^{-1}$ (10 marks)

b) State the rule of mutual exclusion in Raman spectroscopy. (3 marks)

c) State two facets of NMR. (4 marks)

d) Explain the term chemical shift. (3 marks)

--END--