

**W1-2-60-1-6**

**JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY**

# **UNIVERSITY EXAMINATIONS 2015/2016**

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ANALYTICAL AND INDUSTRIAL CHEMISTRY**

**SCH 2313 : THEORY OF SPECTROSCOPIC METHODS**

**DATE: AUGUST 2015 TIME: 2 HOURS**

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.**

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**SOME PHYSICAL CONSTANTS:**

**Avogadro’s number = 6.023x1023**

**Planck’s constant, h = 6.626 x 10-34J/S**

**Speed of light in vaccum, c= 2.998x108ms-1**

**QUESTION ONE [30 MARKS]**

1. What is spectroscopy? List the major regions of the electromagnetic spectrum clearly and the spectroscopic techniques associated with them. [8 marks]
2. Explain why absorption by poly atomic molecules is more complex than atomic absorption. [2 marks]
3. Green light has a wavelength of approximately 530nm in a vacuum. Calculate the frequency , the wavelength (, and the wave-number for green light in water. Use the following data: nvacuum = 1.000, nwater = 1.332, where n represents refractive index. [6 marks]
4. When potassium atoms are excited in a flame, light of wavelength 766.5nm is emitted. Calculate the frequency and energy associated with this wavelength. [4 marks]
5. Which of the following molecules are Infrared active and which are Raman active? Explain:

N2, HCl, C0, Cl2 [6 marks]

1. A 2.83x10-4M solution of potassium permanganate has an absorbance of 0.510 when measured in a 0.982- cm cell at 520nm. Calculate :
2. The molar absorptivity for KMn04 at this wavelength . [2 marks]
3. The absorptivity when the concentration is expressed in ppm, i.e mg/L. [2 marks]

[use Relative atomic massed: K=39, Mn=55, 0=16]

**QUESTION TWO [20 MARKS]**

1. Giving examples where possible, describe four (4) major sources of deviation from Beer-Lambert’s Law. [7 marks]
2. With the aid of suitable well-labeled diagram, distinguish between singlet and triplet (ground and excited ) states. [5 marks]
3. Using a suitable diagram and explanations, describe the origin of fluorescence and phosphorescence. [8 marks]

**QUESTION THREE [20 MARKS]**

1. Describe briefly the basis and requirements of Infrared spectroscopy and Raman spectroscopy. [6 marks]
2. Calculate the expected frequency, wave number (in cm-1) and wavelength (in μm) of the fundamental absorption peak due to the stretching vibration of a  (nitrile) group. (Use the following data:

* For the  bond, force constant,  dynes/cm.
* Reduced mass, , where MH = Mass of a hydrogen atom = 1.67339x10-24g) [8 marks]

1. Calculate the number of normal vibrational modes expected for the following molecules:
2. H2S [2marks]
3. C02 [2 marks]
4. C2H4 [2 marks]

**QUESTION FOUR [20 MARKS]**

Using suitable examples, describe the principles and applications of the following

spectroscopic techniques:

1. Nuclear Magnetic Resonance [NMR] spectroscopy. [14 marks]
2. Electron Spin Resonance [ESR] spectroscopy. [6 marks]