SOUTH EASTERN KENYA UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (CHEMISTRY)

SCA 301: INSTRUMENTAL METHODS OF ANALYSIS

DATE: 15TH DECEMBER, 2016 TIME: 8.00-10.00 A.M

INSTRUCTIONS TO CANDIDATES

(a) Answer question One and any other Two questions

(b) Question 1 carries 30 marks while the other questions carry 20 marks each

(c) Illustrate your answers with well label diagrams where applicable

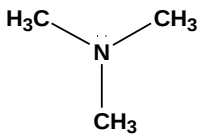
Question 1 (30 marks)

a) Calculate the % Transmittance of tetraamminediaquacopper (II) ions $[Cu(NH_3)_4(H_2O)_2]^{2+}$ complex whose absorbance is 0.318. **(4 marks)**

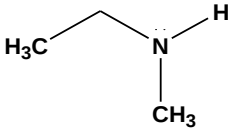
b) A solution containing 4.48 ppm of $KMnO_4$ has a transmittance of 0.309 in a 1.00 cm cell at 520 nm. Calculate the molar absorptivity of $KMnO_4$.

(RMM $KMnO_4$ = 158.034) **(5 marks)**

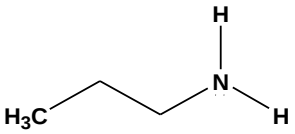
c) Explain how it would be possible to distinguish among the following three isomers of C_3H_9N based upon infrared spectra. **(3 marks)**



I



II



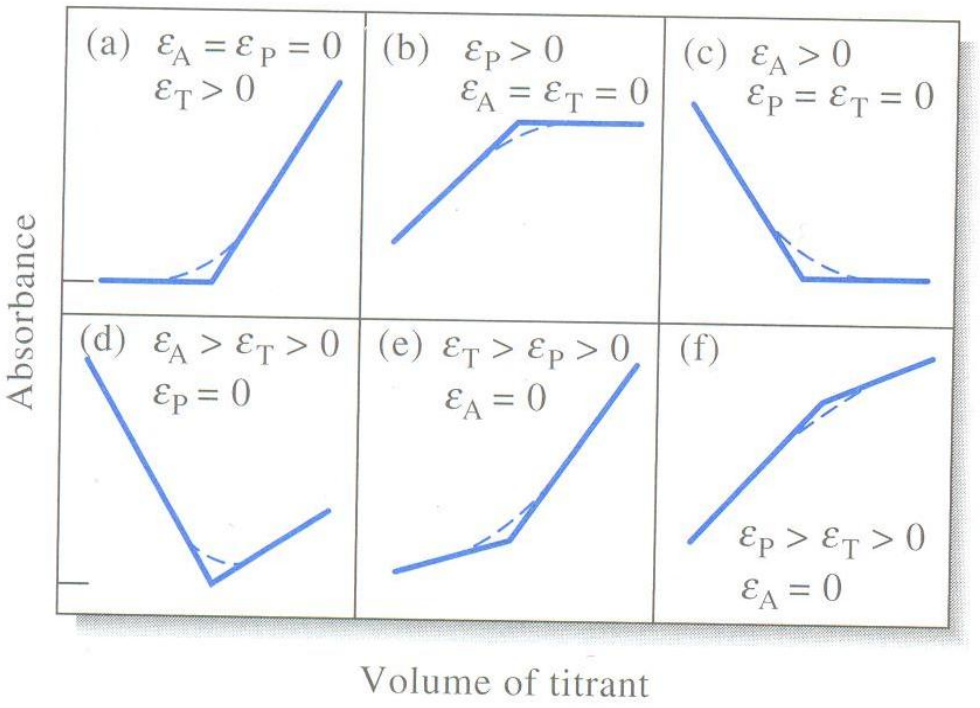
III

d) Palladium (II) and gold (III) were analyzed simultaneously by first reacting a mixture of the two metals with methiomeprazine ($C_{19}H_{24}N_2S_2$). The absorption maximum for the Pd complex occurs at 480 nm, while that for Au complex is at 635 nm. The molar absorptivity data at these wavelengths are

	Molar Absorptivity, ε	
	480 nm	**635 nm**
Pd complex	3.55×10^3	5.64×10^2
Au complex	2.96×10^3	1.45×10^4

A 25.0 mL sample was treated with an excess of methiomeprazine and subsequently diluted to 50.0 mL. Calculate the molar concentrations of Pd (II) and Au (III) in the sample if the diluted solutions had an absorbance of 0.533 at 480 nm and 0.590 at 635 nm when measured in a 1.00 cm cuvette. **(10 marks)**

e) Describe each of the photometric titration curves in the figure below. *Hint*: The symbols ε = molar absorptivity; A = analyte; P = product and T = titrant**(8 marks)**



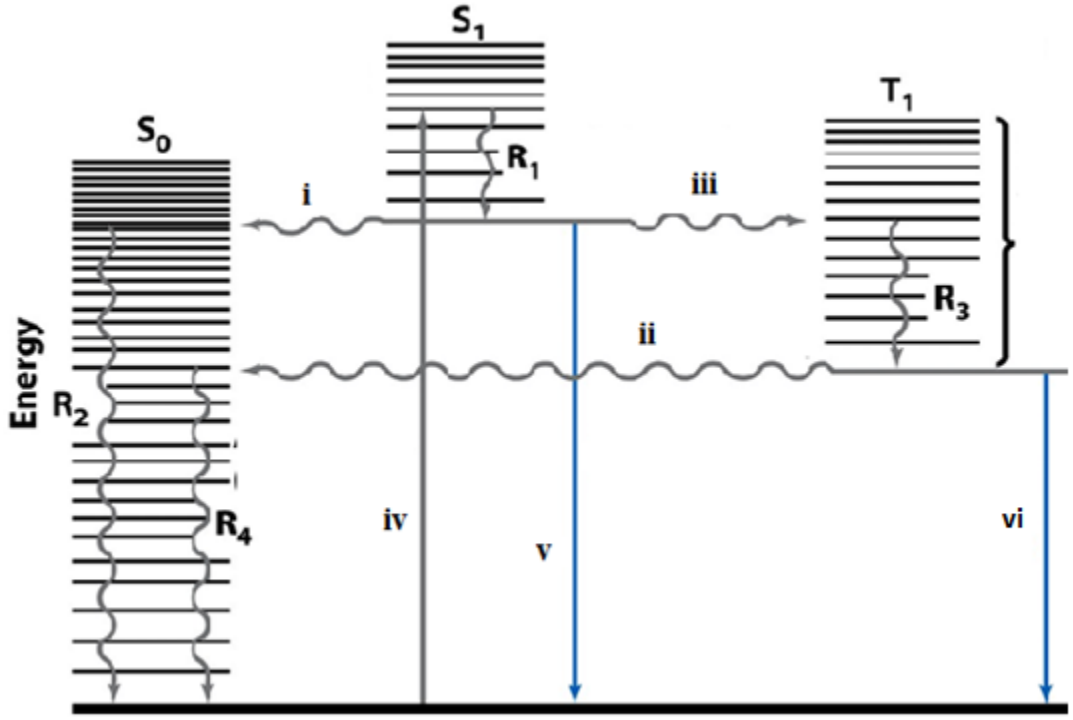
Question 2 **(20 marks)**

The absorption of UV or visible radiation corresponds to the excitation of outer electrons.

a) With the help of a diagram, give FOUR possible types of electronic transitions involving; n, σ, σ*, π, π *. Give the names of each of these symbols. (6 marks)

b) Explain why most absorption spectroscopy of organic compounds is based on transitions of n or π electrons to the $n\square\square^*$ and $\square\square\square^*$ transitions? Comment on the molar absorptivities of absorptions involving these transitions. (8 marks)

c) The diagram below represents radiant processes that occur when a photon is absorbed by a molecule. **(6 marks)**



Identify the processes labelled **(i)** to **(vi)**

Question 3 **(20 marks)**

a) State any FIVE atomization sources employed in atomic spectroscopy (5 marks)
b) The diagram below represents an ICP torch. Identify the part labelled a – e.

(5 marks)

c) Argon is the gas of choice in ICP-AES/ ICP-MS. State Five properties that make it the most ideal gas for emission spectrometry. **(10 marks)**

Question 4 **(20 marks)**

a) State two differences between atomic absorption and atomic emission spectroscopy. **(4 marks)**

b) Identify the processes that a sample undergoes during atomization in a flame atomizer. (4 marks)

c) Identify FOUR sources of line broadening in atomic spectroscopy **(4 marks)**

d) The effectiveness of atomic spectroscopy depends, to a large extend, on the atomization-excitation sources. State any **FOUR** characteristics that a good atomization-excitation source should have. **(8 marks)**

Question 5 **(20 marks)**

The molar absorptivities data for the cobalt and nickel complexes with 2,3-quinoxalinedithiol are as shown in the table below

λ_{max}	**Molar absorptivity,ε**	
	Co	Ni
510	36400	5520
656	1240	17500

A 0.425 g sample was dissolved and diluted to 50 mL. A 25.0 mL aliquot was treated to eliminate interference; after addition of 2,3-quinoxalinedithiol, the volume was adjusted to 50.0 mL. This solution had an absorbance of 0.446 at 510 nm and 0.326 at 656 nm in a 1.00 cm cell.

Calculate the concentration **(in µg/g)** of cobalt and nickel in the sample. (RAM of Ni = 58.69 and Co = 58.93). **(20 marks)**