THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. Degree Programme / Stand alone courses 2007 / 2008
Level 5 – Continuous Assessment Test I

CHU 3129 – INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Duration: one and half hours

Date : 16th March, 2008
From 1.30 p.m. to 3.00 p.m.

Reg. No. .....

Question No.	Marks
1	
2	
3	
4	
Total	
Percentage	

Instructions to candidates

- **Answer all questions.**
- **Write down the answers in the spaces provided in the paper itself. Attached sheets will not be graded.**

1. Explain the following terms briefly.

(i) Band spectra

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(10 marks)

(ii) Double beam spectrophotometer

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(10 marks)

(iii) Phosphorescence

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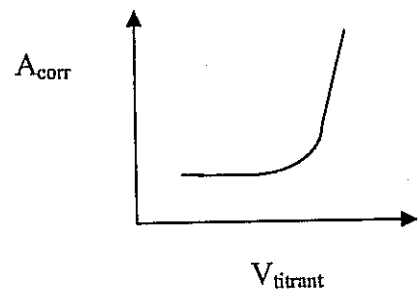
(10 marks)

2. A photometric titration was carried out to determine the concentration of the analyte X (25.0 cm^3) with the titrant Y. A plot of corrected absorbance (A_{corr}) *vs* volume of titrant added ($V_{titrant}$) obtained was as follows.



(i) Comment on the light absorbing property of X, Y and the product.

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(06 marks)

(ii) Y (25.0 cm^3) was titrated using analyte X as the titrant. Draw a schematic diagram of the expected graph of corrected absorbance (A_{corr}) *vs* volume of titrant added ($V_{titrant}$). (10 marks)

3. Wavelength of maximum absorbance and the corresponding molar absorptivities are given below for different molecules P, Q and R.

Molecule	λ_{max} (nm)	ε ($Lmol^{-1}cm^{-1}$)
P	198	10,000
Q	245	85,000
R	598	74,000

(i) What is / are the molecule / molecules that cannot be detected using colorimeter ?

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(04 marks)

(ii) Out of the above three molecules, what is the most sensitive molecule that can be detected using UV- Visible spectrophotometer ?

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(05 marks)

(iii) Explain your answer for question 3(ii) briefly using appropriate equation/equations.

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(10 marks)

(iv) "The molar absorptivity (ε) is a constant to a particular absorbing species." Comment briefly on this statement.

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(10 marks)

4. Two complexes "R" and "S" have ε values ε_R = 1450 ($Lmol^{-1}cm^{-1}$) and ε_S = 3190 ($Lmol^{-1}cm^{-1}$) at 310 nm, and ε_R = 322 ($Lmol^{-1}cm^{-1}$) and ε_S = 210 ($Lmol^{-1}cm^{-1}$) at 650 nm. When a solution containing these complexes was placed in a 1.00 cm cell and the absorbance measured at these wavelengths, it was found that A = 0.1500 at 650 nm and A = 0.7005 at 310 nm. Calculate the concentrations of "R" and "S" in the solution showing the main steps and give the concentrations with three significant figures.

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(25 marks)

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CHU 3129 INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Answer guide to continuous assessment test 1

(1) (i) Band spectra

Molecules have several vibrational and rotational energy levels with in the electronic states. When an electronic transition takes place in a molecule, it goes from vibrational state of an electronic state with a low energy level to any high energy level. Therefore, light absorbed or emitted can have several slight different energies thus resulting band spectra. It consists of broad bands of wavelengths.

(ii) Double beam spectrophotometer

Here, the incident light beam is split in to two identical beams, with the blank being inserted in to one beam and the sample in to the other, so that both measurements can be made simultaneously.

(iii) Phosphorescence

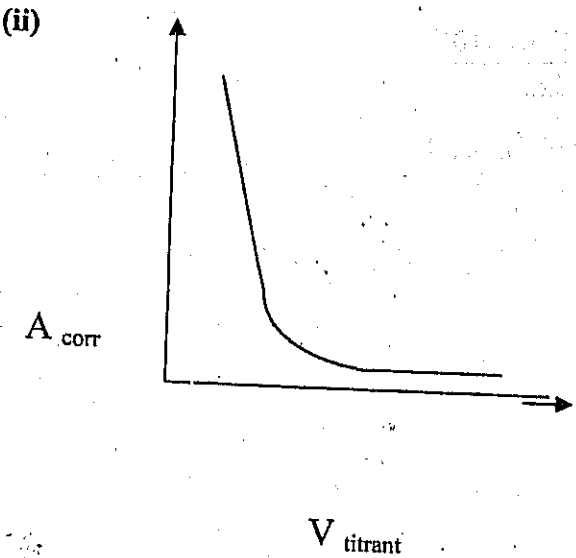
Phosphorescence is resulted when molecules relax from the triplet excited state back to the singlet ground state with the emission of a photon of light.

(2) (i) x - not absorbing

Y - absorbing

product- not absorbing

(ii)



(3) (i) P & Q

(ii) Q

(iii) $A = \varepsilon C l \qquad C = \frac{A}{\varepsilon l} \qquad C \propto \frac{1}{\varepsilon}$

Higher the ε , lower will be the C

(iv) ε is a constant to a particular absorbing species at a constant temperature for a particular λ

(4) $A_{total} = \varepsilon_R C_R l_R + \varepsilon_S C_S l_S$

At 650 nm $\quad 0.15 = 322\, C_R\,(1) + \ 210\, C_S(1) \longrightarrow (1)$

At 310 nm $\quad 0.7005 = 1450\, C_R(1) + 3190\, C_S(1) \longrightarrow (2)$

From 1, $\quad C_R = \frac{0.15 - 210\, C_S}{322}$

Substituting 2, $\quad 0.7005 = 1450\left(\frac{0.15 - 210 C_S}{322}\right) + 3190 C_S$

$$0.7005 = 0.67546 - 945.6572 C_S + 3190 C_S$$

$$0.02504 = 2244.3479 C_S$$

$$C_S = 1.110 \times 10^{-5}\, mol\, l^{-1}$$

$$C_R = \frac{0.15 - 210\left(1.110 \times 10^{-5}\right)}{322}$$

$$C_R = \frac{0.15 - 233.1 \times 10^{-5}}{322}$$

$$C_R = 45.86 \times 10^{-5}\, mol\, l^{-1}$$