C 241 (Experiment No._____)

NAME:_____ **BATCH:_____**

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SIMULTANEOUS DETERMINATION OF COMPOSITION OF BINARY MIXTURES (SPECTROPHOTOMETRIC ANALYSIS)

AIM

To determine the simultaneous spectrophotometric analysis of composition of binary mixtures using UV-Visible instrument.

THEORY

The experiment concerned with the simultaneous spectrophotometric determination of two solutes in a solution. The absorbances are additive, provided there is no reaction between the two solutes. Hence we may write

$$A\lambda_1 = \lambda_1 A_1 + \lambda_1 A_2 \quad \text{------ (1)}$$

$$\text{and} \quad A\lambda_2 = \lambda_2 A_1 + \lambda_2 A_2 \quad \text{------ (2)}$$

where A_1 and A_2 are the measured absorbances at the two wavelengths λ_1 and λ_2 respectively. The subscripts 1 and 2 refer to the two different substances, λ_1 and λ_2 refers to the different wavelengths. The wavelengths are selected to coincide with the absorption maxima of the two solutes; the absorption spectra of the two solutes should not overlap appreciably, so that substance 1 absorbs strongly at wavelength λ_1 and weakly at wavelength λ_2, and substance 2 absorbs strongly at λ_2 and weakly at λ_1. Now, $A = \varepsilon c l$, where ε is the molar absorption coefficient at any particular wavelength, c is the concentration (mol L^{-1}) and **l** is the thickness or length of the absorbing solution (cm). if **l** = 1 cm then

$$A\lambda_1 = \lambda_1 \varepsilon_1 c_1 + \lambda_1 \varepsilon_2 c_2 \quad \text{------ (3)}$$

$$\text{and} \quad A\lambda_2 = \lambda_2 \varepsilon_1 c_1 + \lambda_2 \varepsilon_2 c_2 \quad \text{------ (4)}$$

Solutions of these simultaneous equations gives

$$C_1 = (\lambda_2 \varepsilon_2 A\lambda_1 - \lambda_1 \varepsilon_2 A\lambda_2) / (\lambda_1 \varepsilon_1 \lambda_2 \varepsilon_2 - \lambda_1 \varepsilon_2 \lambda_2 \varepsilon_1) \quad \text{------ (5)}$$

$$C_2 = \lambda_1 \varepsilon_1 A\lambda_2 - \lambda_2 \varepsilon_1 A\lambda_1) / (\lambda_1 \varepsilon_1 \lambda_2 \varepsilon_2 - \lambda_1 \varepsilon_2 \lambda_2 \varepsilon 1) \quad \text{------ (6)}$$

The values of molar absorption coefficients ε_1 and ε_2 can be deduced from measurements of the absorbances of pure solutions of substances 1 and 2. By measuring absorbance of the mixture at wavelengths λ_1 & λ_2, the concentrations of the two components can be calculated.

MATERIALS REQUIRED

Stock solution of 0.01 M $K_2Cr_2O_7$ and $KMnO_4$, 0.1 M H_2SO_4, 0.7 M H_3PO_4, volumetric flasks (250 mL, 50 mL), pipettes, burette (50 mL), distilled water, UV-VIS spectrophotometer with cuvettes.

PROCEDURE

Preparation of standard solutions:

1. Prepare a set of 0.001 M (250 mL), 0.0005 M (25 or 50 mL) and 0.00025 M (25 or 50 mL) solutions of potassium dichromate.
2. Prepare a set 0.001 M (25 or 50 mL), 0.0005 M (250 mL) and 0.00025 M (25 or 50 mL) potassium permanganate

   Note: The solution will be prepared in the supplied mixture of 1 M H_2SO_4 and 0.7 M H_3PO_4.

   (Total 6 solutions, three each)

Experiment:

3. Measure absorbance **A** for all three set of solutions of $K_2Cr_2O_7$ (1 mL) and $KMnO_4$ (1 mL) at both wavelengths 440 nm and 545 nm. (for eg. mix 1 mL of 0.001 M $K_2Cr_2O_7$ and 0.001 M $KMnO_4$ together in a cuvette and record at both the wavelengths)

4. Calculate ε in each case by A = ε c l and record the mean values for dichromate and permanganate at the two wavelengths.

Concentration (Mixure of $K_2Cr_2O_7$ & $KMnO_4$)	At λ440 nm		At λ545 nm	
	Absorbance	ε(Cr)	Absorbance	ε(Mn)
0.001 M (1 mL each)				
0.0005 M (1 mL each)				
0.00025 M (1 mL each)				
	Average (ε):		Average (ε):	

5. Mix dichromate (0.001 M) and permanganate (0.0005 M) solutions according to following table. In each case, the total volume should be 25 mL.
6. To each of these solutions add 1.0 mL of conc. H_2SO_4.
7. Measure the absorbance of each of these solutions at 440 nm and 545 nm.
8. Record the absorbance of the unknown solution supplied.

OBSERVATIONS CALCULATIONS AND RESULTS

S.No	$K_2Cr_2O_7$ solution (mL)	$KMnO_4$ solution (mL)	Absorbance at 440 nm observed calculated	Absorbance at 545 nm observed calculated
1	25	0		
2	22.5	2.5		
3	20	5		
4	17.5	7.5		
5	15	10		
6	12.5	12.5		
7	10	15		
8	7.5	17.5		
9	5	20		
10	2.5	22.5		
11	0	25		
12	Unknown			

A440 = 440 ε (Cr) C(Cr) + 440 ε (Mn) C(Mn)

A545 = 545 ε (Cr) C(Cr) + 545 ε (Mn) C(Mn)

Calculate the concentrations of dichromate and permanganate in the unknown solution?

Comment on Graphs?