Department of Chemistry

College of Science

University of Salahaddin

Subject: Analytical Chemistry

Course Book – (Year 1)

Lecturer's name: Assist. Prof. PhD. Hijran Sanaan Jabbar

& M.Sara Hadi

Academic Year: 2023/2024

Course Book

1. Course name	**Analytical Chemistry**
2. Lecturer in charge	**Theory: Assist. Prof. Dr. Hijran Sanaan Jabbar** **Practical: Dr.Hijran S., & M.Sara Hadi**
3. Department/ College	**Earth Sciences - Science**
4. Contact	**e-mail: hijran.jabbar@su.edu.krd**
5. Time (in hours) per week	**Theory: 2** **Practical: 3**
6. Office hours	**Sunday: 10:30 – 11:30, 12:30 – 13:30** **Tuesday: 10:30 – 11:30, 13:30 – 14:30** **Wednesday: 10:00 – 10:30**
7. Course code	

8. Teacher's academic profile

Academic achievements and Qualifications: (starting from the most recent degree)

From- To	Degree	College-University	Country
2013 to date	PhD in Analytical Chemistry, Department of Chemistry	College of Science- University of Salahaddin	Iraq
2006 – 2013	M. Sc. in Analytical Chemistry, Department of Chemistry	College of Science- University of Salahaddin	Iraq
1997 – 2002	B.Sc. Chemistry, Department of Chemistry,	College of Science- University of Salahaddin	Iraq

Experiences: (starting from the most recent position), please mention Year, Position and Place

1- Assignments and Posts:

From- To	Post	Department -College	University
2018 to date	Assistant Professor	Chemistry Department-College of Science	Salahaddin University
2013 – 2018	Lecture	Chemistry Department-College of Science	Salahaddin University
2006 – 2013	Assistant Lecture	Chemistry Department-College of Science	Salahaddin University
2002 – 2006	Reporter in Chemistry Department	Chemistry Department-College of Science	Salahaddin University
2007 – 2009	Member of Examination Committee	Chemistry Department-College of Science	Salahaddin University

2- Teaching Activities

From- To	Subject	Stage-College	University
2013- to date	Introduction to Analytical Chemistry – Volumetric Analysis	1st- year students / Environmental Department-College of Science	Salahaddin University
2013 to date	Computer Science (Theory and Practical)	1st- year students / Chemistry Department-College of Science	Salahaddin University
2009 to date	Environmental Application of Analytical Chemistry – Practical	1st- year students / Environmental Department - College of Science	Salahaddin University
2009-2010	Analytical Chemistry-Separation Methods – Practical	3rd- year students / Chemistry Department-College of Science	Salahaddin University
2006-2009	Analytical Chemistry-Gravimetric Analysis – Practical	College of Science, University of Salahaddin	Salahaddin University

9. Keywords	Analytical chemistry, Volumetric analysis, Titration method (Neutralization titration, Precipitation titration, Oxidation-Reduction titration and Complexometric titration), Unit expression (Molarity, Normality, ppm…etc)

10. Course overview:

Analytical chemistry is a branch of chemistry which is both broad in scope and requires a specialised and disciplined approach. Its applications extend to all parts of an industrialised society.'

“Introduction to Analytical Chemistry”, is designed to introduce students to the topic of chemical detection and measurement (qualitative and quantitative analysis). As well as being a varied and interesting discipline in its own right, analytical chemistry plays an essential role in many important fields such as biochemistry, clinical chemistry, environmental science, food and nutrition and pharmaceutical chemistry. Analytical chemistry touches every aspect of our daily lives. This subject was studied by the student in two courses.

During semester period, We try to provide a fundamental approach to chemical equilibrium, including calculations of chemical composition and of equilibrium concentrations acid/base systems. Buffer solutions, which are extremely important areas of science, are also discussed, and the properties of buffer solutions are described.

This semester is designed for college students majoring in chemistry and fields related to chemistry. They deal with the principles and methods of classical quantitative analysis, that is, how to determine how much of specific substance is contained in a sample. We will learn how to design an analytical method, based on what information is needed, how to obtain a laboratory sample that is representative of the whole, how to prepare its solution for analysis, and what measurement tool are available.

11. Course objective:

This course provides an introduction to the fundamental principles of chemical analysis. It will teach you how to correctly handle and interpret experimental measurements; you will also learn how to perform an analytical procedure like volumetric analysis.

12. Student's obligation

Each student at the end of the course must be preparing a report about any titration methods other than that mentioned or discussed during the course. This report includes Theory, principle and discussion on the selected technique how it helps to improve the understanding of the principles.

13. Forms of teaching

Data show and white board

14. Assessment scheme

The students are required to do two closed exams during the course period.

Exams (closed and optional): 10

Absence: 2

Quiz, classroom participation and assignments: 3

Practical: 35%

Final Exam: 60% which include 45% for theoretical and 15% for practical.

15. Student learning outcome:

Students should know the basic principles and have actual practice with the operational techniques of a wide variety of separation methods. In addition, they should be familiar with a great many other methods of separation that may be useful in the future.

16. Course Reading List and References:

The student can find additional information and examples in the following references

1. Modern Analytical Chemistry; by David Harvey.
2. Fundamentals of Analytical Chemistry; Eighth Edition, by Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch.
3. Principles and Practice of Analytical Chemistry, Fifth Edition, by F.W. Fifield and D. Kealey.
4. Vogels, Textbook of Quantitative Chemical Analysis, Fifth Edition, G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney.
5. Quantitative Chemical analysis, Seventh Edition, -Daniel C. Harris.

17. The Topics:	Lecturer's name
First Course Course Program (Analytical Methods)	Dr. Hijran Sanaan Jabbar (2 hrs)
	Week 1
General Introduction to analytical Chemistry 1- Qualitative analysis 2- Quantitative analysis	
	Week 2 – 5
Units for Expressing Concentration 1. Molarity and Formality 2. Normality 3. Molality 4. Weight, Volume, and Weight-to-Volume Ratios 5. Converting Between Concentration Units Preparing Solutions 1. Preparing Stock Solutions (solid and liquid) 2. Preparing Solutions by Dilution	
	Week 5-7
Volumetric Methods of Analysis -Titration - Volume as a Signal -Titration Curves - The Burette -Equivalence Points and End Points -Chemical indicator	
	Week 8
- Acid–Base Titrations (Neutralization) -Overview of Acid-Base reactions and properties - Buffer solution	
	Week 9-10
Acid-Base titration Curve 1- Strong Acid-Strong Base Titration Curve 2- Weak Acid- Strong Base Titration Curve 3- Examples	
	Week 11
Closed Exam	
	Week 12 – 15

Second Course **Precipitation Titration** Argentometric Titration Endpoint Detection Methods for Argentometric Titration Titration Curve Construction	**Week 1 – 4**
Oxidation-Reduction (Redox) Titration -Terminology for Redox Reactions -Balancing Redox reactions -Quantitative Applications -Chemical Change to Electric Current -Type of Cells and Cell Potential -Oxidation-Reduction titration Curve - Redox Indicators	**Week 5 – 7**
Closed Exam	**Week 8**
Complex Formation Titration (Complexometry) -Complex Formation and Conditions of Ligand -Ligands type -Titration Methods Employing EDTA -Indicator for EDTA titration	**Week 9 – 11**
Optional Exam	**Week 12**
Gravimetric Methods of Analysis Overview of Gravimetric method of analysis	**Week 13 – 15**
18. Practical Topics (If there is any)	
First Course: ***Week 1*:** *Preliminary Concept of Quantitative Analysis, Common Apparatus and Basic Techniques.* ***Week 2*:** *- Explanation of Volumetric analysis* *-Laboratory Note and Techniques.* *-Methods of Expressing Analytical Concentration.* ***Experimental No: 1*** *Preparation of solution from a solid and a liquid material.* ***Week 3:***	

Volumetric Analysis (Acid-Base Titration)

Experimental No: 2

Preparation and Standardization of 0.1 N Hydrochloric acid HCl).

Week 5:

Volumetric Analysis (Acid-Base Titration)

Experimental No: 3

Preparation and Standardization of 0.1 N Sodium Hydroxide (NaOH).

Week 6:

Volumetric Analysis (Acid-Base Titration)

Experimental No: 4

Preparation and Standardization of 0.1 N acetic acid (CH_3COOH).

Application: Determination of Actic Acid in Vinegar.

Week 7:

Volumetric Analysis (Precipitation Titration)

Experimental No: 6

Preparation and standardization of $AgNO_3$ Solution by Mohr Method

Application: Determination of Cl^- in SolubleCl^- Solutions.

Week 8:

Volumetric Analysis (Precipitation Titration)

Experimental No: 7

Determination of Cl^- in Soluble Cl^- Solutions by Volhard.

Week 9:

Exam - Practic

Week 10:

Seminar

Second Course:

Week 1:

Volumetric Analysis (Oxidation-Reduction Titration)

Experimental No: 8

Determination of Ferrous Iron Using Standard $K_2Cr_2O_7$ Solution.

Week 2:

Volumetric Analysis (Oxidation-Reduction Titration)

Experimental No: 9

Preparation and Standardization of 0.1 N KMnO4 and Determination of Ferrous ions.

Week 3:

Volumetric Analysis (Oxidation-Reduction Titration)

Experimental No: 10

Determination of Solution of Hydrogen Peroxide.

Week 4:

Volumetric Analysis (Oxidation-Reduction Titration)

Experimental No: 11

Determination of Hypochlorite in Bleach

Week 5:

Volumetric Analysis (Complexometric Titration)

Experimental No: 12

Standardization of EDTA and Determination of Some Metal Ions.

Week 6:

Volumetric Analysis (Complexometric Titration)

Experimental No: 13

Determination of Hardness of Water Sample.

Week 7:

Exam

Week 8:

Gravimetric analysis

Experimental No: 14

Determination of Water of Hydration in Crystallized barium chloride.

Week 9:

Gravimetric analysis

Experimental No: 15

Determination of Water of Sulphate as barium sulphate.

Week 10:

Gravimetric analysis

Experimental No: 16

Determination of Sulphate as barium sulphate.

Week 11:

Gravimetric analysis

Experimental No: 17

Determination of Nickel by organic precipitant reagent.

Week 12:

Qualitative Analysis: *Analysis of Group (I) Cations*

Week 13:

Qualitative Analysis: *Analysis of Group (II) Cations*

Week 14:

Seminar	

19. Examinations:

Q1/ Calculate the pH and pOH for each of the following solution (answer only five):

a) 0.021M NaOH solution.

b) A solution prepared from the mixing of 50.0 mL of 0.02 M HCl with 25 mL of 0.01M KOH.

c) 0.01 M H_2C_2O4 solution. ($Ka_1 = 5.9 \times 10^{-2}$; $Ka_2 = 6.4 \times 10^{-5}$)

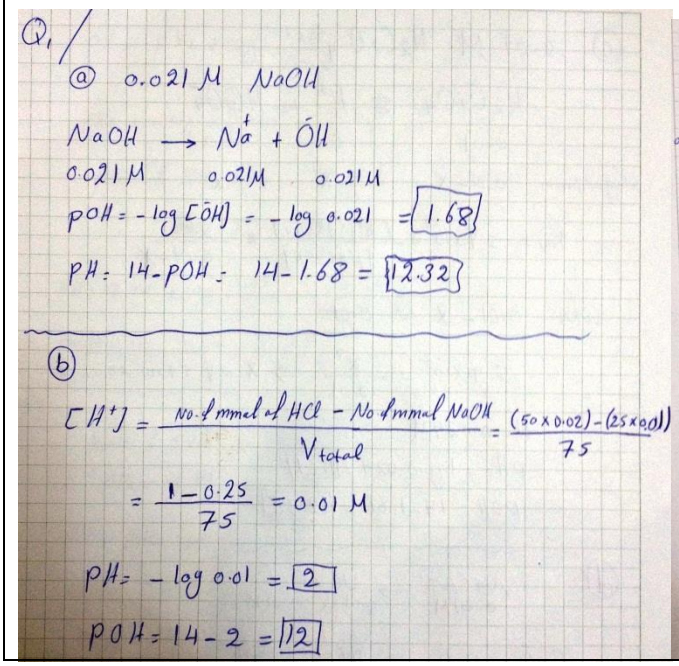
d) 0.01M sodium cyanide solution. (Ka HCN = 4.0×10^{-10})

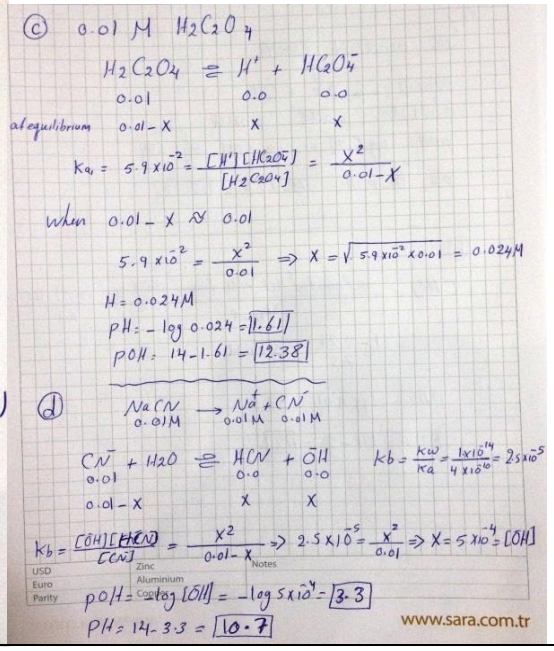
e) A buffer solution is prepared by mixing 500.0 mL of 0.10 M NaOCl and 500.0 mL of 0.20 M HOCl. [Ka(HOCl) = 3.2×10^{-8}].

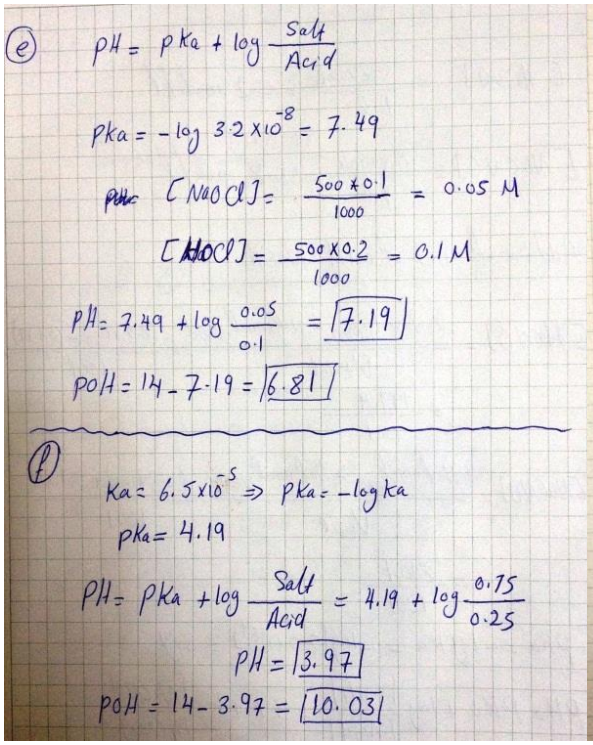
f) A buffer solution that contains 0.25M Benzoic acid (C6H5CO2H) and 0.15 M sodium benzoate (C_6H_5COONa). [Ka ($C_6H5CO2H$) = 6.5×10^{-5}].

g) A buffer solution prepared by dissolving 0.2 mole of cyanic acid (HCNO) and 0.8 mol of sodium cyanate (NaCNO) in enough water to make 1.0 liter of solution, Calculate the pH and pOH after addition of 1 mL of 0.1 M NaOH. [Ka(HCNO) = 2.0×10^{-4}]

Answer/







(e) $pH = pKa + \log \frac{Salt}{Acid}$

$pKa = -\log 3.2 \times 10^{-8} = 7.49$

$[NaOCl] = \frac{500 \times 0.1}{1000} = 0.05\ M$

$[HOCl] = \frac{500 \times 0.2}{1000} = 0.1\ M$

$pH = 7.49 + \log \frac{0.05}{0.1} = \boxed{7.19}$

$pOH = 14 - 7.19 = \boxed{6.81}$

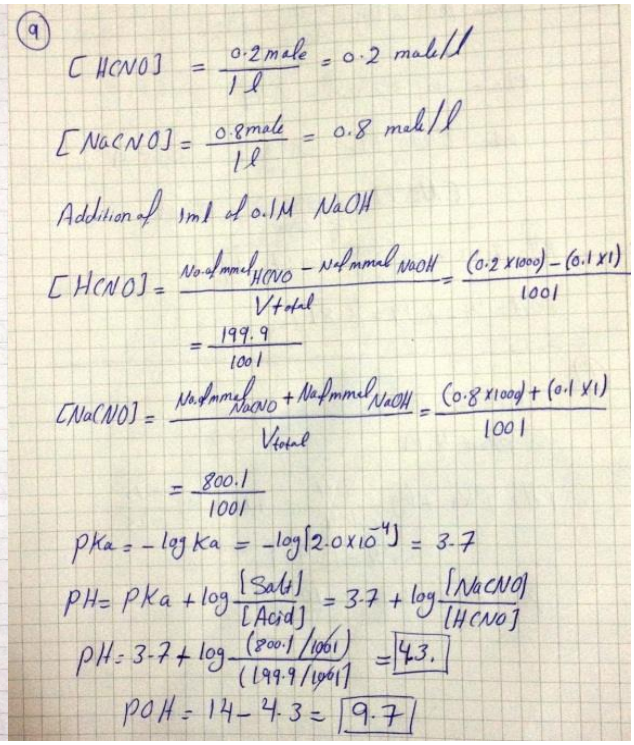
(f) $Ka = 6.5 \times 10^{-5} \Rightarrow pKa = -\log ka$

$pKa = 4.19$

$pH = pKa + \log \frac{Salt}{Acid} = 4.19 + \log \frac{0.75}{0.25}$

$pH = \boxed{3.97}$

$pOH = 14 - 3.97 = \boxed{10.03}$



(g) $[HCNO] = \frac{0.2\ mole}{1\ l} = 0.2\ mole/l$

$[NaCNO] = \frac{0.8\ mole}{1\ l} = 0.8\ mole/l$

Addition of 1ml of 0.1M NaOH

$[HCNO] = \frac{No.of\ mmol_{HCNO} - No.of\ mmol_{NaOH}}{V_{total}} = \frac{(0.2 \times 1000) - (0.1 \times 1)}{1001}$

$= \frac{199.9}{1001}$

$[NaCNO] = \frac{No.of\ mmol_{NaCNO} + No.of\ mmol_{NaOH}}{V_{total}} = \frac{(0.8 \times 1000) + (0.1 \times 1)}{1001}$

$= \frac{800.1}{1001}$

$pKa = -\log ka = -\log[2.0 \times 10^{-4}] = 3.7$

$pH = pKa + \log \frac{[Salt]}{[Acid]} = 3.7 + \log \frac{[NaCNO]}{[HCNO]}$

$pH = 3.7 + \log \frac{(800.1/1001)}{(199.9/1001)} = \boxed{4.3.}$

$pOH = 14 - 4.3 = \boxed{9.7}$

20. Extra notes:

21. Peer review