Home

CHE-305-MJP: PHYSICAL CHEMISTRY PRACTICAL I

Course Type: Major Practical **Credits: 2**

A. Course Objectives:

1. To perform quantitative analysis and interpret experimental data.
2. To introduce basic computational chemistry tools.
3. To provide training in potentiometry and pH metry techniques.
4. To familiarize students with experimental methods in radioactivity and colligative properties.
5. To develop understanding of quantitative experimental procedures in physical chemistry.
6. To introduce the use of basic computational chemistry tools.
7. To inculcate skills in accurate observation, data recording, and scientific reporting.

B. Course Outcomes (COs):

CO No.	Course Outcome Statement (COs) *After learning the course, the students are able to -*
CO-1	Recall principles of potentiometry, pH metry, radioactivity, and colligative properties.
CO-2	Explain experimental techniques and underlying concepts
CO-3	Perform experiments to determine pKa, EMF, Ksp, and molecular weight.
CO-4	Analyze experimental data, graphs, and results from electrochemical and physicochemical methods.
CO-5	Evaluate accuracy, errors, and reliability of experimental observations and results.
CO-6	Prepare systematic laboratory reports.

C. Contents:

Prerequisites
Students should have basic knowledge of physical chemistry concepts such as electrochemistry, chemical equilibrium, and solutions. Familiarity with basic laboratory practices, handling of instruments (pH meter, burette, etc.), and simple calculations is required. Basic understanding of data recording and safety procedures is expected.
A minimum of 12 experiments are to be completed.
A. Potentiometry (any five)

1. To determine the pKa value of a given monobasic weak acid by potentiometric titration.To determine the formal redox potential of the Fe^{2+}/ Fe^{3+} system
2. potentiometrically.
3. To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.
4. To determine the solubility product and solubility of AgCl potentiometrically using a chemical cell.
5. Estimate the amount of Cl^-, Br^- and I^- in given unknown halide mixture by titrating it against standard $AgNO_3$ solution (mixture of any two ions).
6. To prepare standard 0.2 M Na_2HPO_4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and unknown solution.
7. To determine the composition of Zinc ferrocyanide complex potentiometrically
8. To determine the standard electrode potentials of Cu and Ag electrodes and to determine the EMF of a concentration cell.

B. pH metry (any three)

1. To determine the degree of hydrolysis of aniline hydrochloride.
2. To determine the dissociation constant of oxalic acid by pH-metric titration with strong base.
3. Determination of Pka of given weak acid by pH metry titration with strong base.
4. To determine the acid and base dissociation constant of an amino acid and hence the isoelectric point of an acid.
5. pH metric titration of strong acid against strong base by pH measurement and hence determine the concentration and strength of strong acid.

C. Radioactivity (any one)

1. To determine plateau voltage of the given G M counter. To determine the resolving time of GM counter.
2. To determine E_{max} of beta particle

D. Colligative properties (any one)

1. To determine the molecular weight of solute by depression in freezing point depression method.
2. To study the association of Benzoic acid in benzene by the Beckmann Method.
3. Determine the molecular weight of the given electrolyte and non-electrolyte by

Landsberger's method and to study the abnormal molecular weight of the electrolyte.

4. Determination of Transition Temperature of hydrated salt and Study of Impurity Effect.

E. Turbidometry: (any one)

1. Determination of SO_4^{2-} and Cl^- by turbidimetric method (turbidimetric titration or calibration curve method)
2. To determine the molecular weight of a given polymer by turbidometry

F. Chemistry with computers (Any one)

1. Geometry Optimization and SCF Energy Calculation of Simple Molecules Using Semi-Empirical Methods (ArgusLab or Avogadro + xtb)
2. Potential Energy Surface Scan of Butane Using Computational Methods. (ArgusLab / Avogadro + ORCA)
3. Calculation of the energy gap between HOMO and LUMO in simple molecules and visualization of molecular orbitals.

References:

1. Practical Physical Chemistry, A. Findlay, T. A. Kitchener, Longmans, Green and Co.
2. Experiments in Physical Chemistry, J. M. Wilson, K. J. Newcombe, A. R. Denko, R. M. W. Richett, Pergamon Press.
3. Senior Practical Physical Chemistry, B. D. Khosla, V. S. Garg, R. Chand & Company, 2019.
4. Experimental Physical Chemistry, D. P. Shoemaker, McGraw-Hill, 7th Edition.
5. Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems, D. C. Young, John Wiley & Sons, 2001.
6. Computational Chemistry Using the PC, D. Rogers, John Wiley & Sons, 3rd Edition, 2003.
7. Molecular Modelling: Principles and Applications, A. R. Leach, Longman, 2nd Edition, 2001.