CHEM 0005 - CHEMISTRY - QUANTITATIVE ANALYSIS

Catalog Description

Prerequisite: Completion of CHEM 1B with grade of "C" or better
Advisory: Eligibility for ENGL 11 strongly recommended
Hours: 144 (36 lecture, 108 laboratory)
Description: Theory and techniques of quantitative chemical measurement, including gravimetric, volumetric, and introductory instrumental analysis. Required for all chemistry, chemical engineering, medicine, dentistry, veterinary medicine, and related majors. (CSU, UC)

Course Student Learning Outcomes

- CSLO #1: Demonstrate the ability to evaluate accuracy, precision, and validity of data.
- CSLO #2: Quantitatively analyze samples for chemical composition using wet-chemical methods.
- CSLO #3: Quantitatively analyze samples for chemical composition using instrumental methods.
- CSLO #4: Determine and/or calculate solution properties utilizing analytical chemistry theories.
- CSLO #5: Demonstrate proficiency in scientific communication.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

144

Outside of Class Hours

72

Total Student Learning Hours

216

Course Objectives

Lecture Objectives:
Analyze and solve problems relating to:
1. Systematic errors;
2. random errors;
3. standard deviation;
4. confidence limits;
5. gravimetric factors;
6. gravimetric analysis;
7. standard solutions;
8. volumetric analysis;
9. gravimetric titrimetry;
10. general aqueous equilibrium;
11. activity coefficients;
12. multi-step aqueous equilibrium;
13. aqueous solubility;
14. titration curves for strong and weak acids and bases;
15. simple and polyfunctional buffer systems;
16. acid/base indicators;
17. the pH of simple and polyfunctional systems;
18. precipitation titrimetry and corresponding titration curves;
19. complex-formation titrations;
20. oxidation/reduction reactions;
21. electrochemical cells and potentials;
22. redox equilibrium constants;
23. redox titration curves;
24. electrogravimetric analysis;
25. coulometric analysis;
26. polarographic and voltammetric analysis;
27. spectrochemical analysis;
28. separation methods and theory.
Laboratory Objectives:
1. Apply laboratory notebook skills;
2. Demonstrate quantitative transfer techniques;
3. Perform volumetric glassware calibration;
4. Perform gravimetric analysis,
5. Perform a redox titration;
6. Perform an EDTA titration;
7. Perform spectrophotometric analysis;
8. Complete a forensics lab project using methods listed in 4-7 and a full statistical analysis.
9. Obtain, record, and analyze observations and measurements.

General Education Information

- Approved College Associate Degree GE Applicability
- CSU GE Applicability (Recommended-requires CSU approval)
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Essay Examinations
  - Example: On an exam a student is asked to explain, in writing, how adding a "common" ion would affect the solubility of a different specific compound (product or reactant).
- Objective Examinations
  - Example: On an objective examination (unit exam), the student is asked to calculate the solubility of barium phosphate in water taking into account the basic nature of the phosphate ion and its related reactions with water.
- Problem Solving Examinations
  - Example: As part of a unit exam a student is asked to analyze how multiple different procedural skills would affect the results of an experiment they are familiar with. For example "explain how would misreading the buret due to a parallaxis error would affect the result for molarity in the standardization portion of a titration."
- Projects
  - Example: Students are asked to complete a forensics project in which they design, write and perform laboratory procedures to match samples from a mock crime scene with samples taken from mock suspects.
- Reports

    - Example: Students are asked to complete an organized report containing pertinent calculations, statistical analysis and discussion of results for each lab, for example Gravimetric analysis of Chloride.
- Skill Demonstrations
    - Example: Students demonstrate laboratory skills needed to titrate a hard water sample with EDTA to determine the concentration.

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. Instructor provides a basic procedure for gravimetric analysis and introduces the concept of gravimetric analysis using lecture and/or multimedia presentation and class discussion. Students edit this basic procedure, adding their own understanding, to produce a more robust procedure that they will use to complete the experiment. This might include diagrams and/or calculations pertaining to the amount of chemicals needed or necessary dilutions. The instructor then reviews the student procedure and oversees the students perform the laboratory experiment based on the procedure that each student prepared. Students perform the experiment and collect qualitative and quantitative data. Students adjust procedure and techniques accordingly with the support of the instructor who facilitates critical thinking. When the analysis is finished, students perform calculations to determine the unknown concentration. Students complete a written or typed formal lab report that contains example calculations, results and discussion of systematic and random errors and a statistical analysis of the trials performed. Students are evaluated on their ability to perform glassware techniques, identify procedural errors, and perform necessary calculations. (Lecture objectives 1-6, 13, 28 and lab objectives 1,2,4,9)

Lecture:

1. Instructor presents the topic of uv/vis analysis using lecture, multimedia presentation. This presentation builds on a prior lesson about calibration curves and error analysis of calibration curves. The instructor demonstrates the use of a spectrometer to find absorbance of a solution. The students use prior learning to perform calculations and propose (in writing) a procedure to make standard solutions. The instructor and students discuss the proposed procedure and the instructor suggests modifications if needed. The students make their standard solutions and create a calibration curve, then use statistical analysis to decide if any calibration points need to be re-analysed. The students analyse a mixture of unknown concentration and use the calibration curve to determine the concentration. Students are evaluated on their ability to perform volumetric glassware techniques, determine limitations of calibration curves using error analysis, produce a usable calibration curve and ability to perform necessary calculations. (Lecture objectives 1,2,3,4,7,8, and 27 and lab objectives 1, 2, 3, 8, 9)

Distance Learning

1. Instructor presents the topic of uv/vis analysis by either recording a lecture and posting it on the LMS or by using an online meeting program to present the information to the students. This presentation builds on a prior lesson about calibration curves and error analysis of calibration curves. The instructor shows examples of current instruments and explains how they would be used to find absorbance of a solution. After the presentation (or watching the video) students use prior learning to perform calculations and propose a procedure to make standard solutions as a discussion board assignment . The instructor then either uses the discussion board format or online class meeting time to discuss the proposed procedures and the instructor suggests modifications if needed. The instructor then provides the students with mock standard solution data and data for an unknown. The students use their mock data to create a calibration curve and use the calibration curve to determine the concentration of the unknown. Students also perform a statistical analysis of the calibration curve to determine possible systematic errors and the effect of those errors on the result of the unknown concentration, including suggesting ways to minimize those errors. This is done as a written assignment similar in format to on ground assignments in the laboratory notebook. Students are evaluated on their ability to determine limitations of calibration curves using error analysis, produce a usable calibration curve, depth of problem solving skills and ability to perform necessary calculations. (Lecture objectives 1,2,3,4,7,8, and 27 and lab objectives 1,7, 9)

Typical Out of Class Assignments

Reading Assignments

1. Read the chapter on gravimetric analysis and be prepared to use the content to participate in the classroom and to complete the assigned problems relating to gravimetric analysis. 2. Read the chapter on titrimetric analysis and be prepared to use the content to participate in the classroom and to complete the assigned problems relating to titrimetric analysis.

Writing, Problem Solving or Performance

1. Write the laboratory report for the gravimetric analysis experiment. 2. Solve problems related to the aqueous equilibrium of insoluble salts of weak acids using systems of equations. For example: Calculate the solubility of barium phosphate in water. 3. Perform the gravimetric analysis experiment for nickel in steel.

Other (Term projects, research papers, portfolios, etc.)

Required Materials

- Quantitative Chemical Analysis
    - Author: Daniel Harris
    - Publisher: Macmillan Learning
    - Publication Date: 2020
    - Text Edition: 10th
    - Classic Textbook?:
    - OER Link:
    - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.

Scientific calculator, goggles and laboratory notebook.