SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY
SAULT STE MARIE, ON

COURSE OUTLINE

Course Title: PRINCIPLES OF CHEMISTRY

Code No.: CHM211 **Semester: III**

Program: ENVIRONMENTAL/WATER RESOURSES/PULP & PAPER

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Date: AUG 2000 **Previous Outline Date: NEW**

Approved: K. DeRosario — Dean; Aug. 23/00 — Date

Total Credits: 5 **Prerequisite(s): ENV103**
Length of Course: 15 weeks **Total Credit Hours: 45**

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I. COURSE DESCRIPTION:

CHM 211-5 is a continuation of the fundamentals of chemistry begun in ENV 103. The major emphasis in the lab is on Quantitative Analysis; the student is expected to analyze a variety of samples and arrive at satisfactory results. The theory component of the course deals with the following concepts: chemical reactions, solution chemistry, chemical calculations, Ksp, Keq, Ka, Kb, Kw, acid-base chemistry, pH, H^+, pOH, OH^-, % ionization of weak acids and bases. These fundamental concepts will allow the student to solve practical problems and provide a basis for understanding the chemistry of subsequent courses.

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

(Generic Skills Learning Outcomes placement on the course outline will be determined and communicated at a later date.)

Upon successful completion of this course the student will demonstrate the ability to:

1) Write and balance chemical equations and identify different types of reactions.

Potential Elements of the Performance:

- Identify the types of reactions common in environmental chemistry.
- Write and balance reactions given either the reactants or products
- Identify ions in aqueous solutions and substances which precipitate or forms gaseous substances.

2) Perform calculations involving compounds in aqueous solutions.

Potential Elements of the Performance:

- Make calculations for preparation of solutions having concentration expressed in M, ppm, and be able to convert from one concentration to another ex. ppm ---> M, M ---> ppm.
- Using solubility rules, decide whether two soluble ionic compounds will or will not react to form a precipitate. If they will, write the net ionic equation.
- Write the molecular equation, and then the net ionic equation for the neutralization of an acid and a base.

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3) Write and balance oxidation – reduction reactions.

Potential Elements of the Performance:

- Write a skeleton equation given as balanced oxidation-reduction equation. Label the oxidizing and reducing agents, the oxidized and reduced species, and the oxidation and reduction parts of the equation. Comment on the reaction by referring to the commonly observed oxidation states.
- Given an oxidation-reduction equation (an unbalanced or a skeleton equation), complete and balance it by the half-reaction method and/or the oxidation number method.
- Make calculations for preparations of solutions having concentrations expressed in N and converting this concentration to M, ppm etc.

4) Use equilibrium concepts to solve for the desired quantities in gaseous reactions.

Potential Elements of the Performance:

- Given the starting amounts of reactants and the amount of one substance at equilibrium, find the equilibrium composition.
- Given the chemical equation, write the equilibrium-constant expression.
- Given the equilibrium composition, find Kc.
- Given the concentrations of substances in a reaction mixture, predict the direction of reaction.
- Given Kc and all concentrations of substances but one in an equilibrium mixture, calculate the concentration of this one substance.
- Given the starting composition and Kc of a reaction mixture calculate the equilibrium composition.
- Given a reaction, use Le Chatelier's principle to decide the effect of adding or removing a substance, changing the pressure, or changing the temperature.

5) Apply the concepts of solubility product to solve problems in solubility equilibria.

Potential Elements of the Performance:

- Given the concentration of hydroxide ion (or concentration of strong base), calculate the hydrogen-ion concentration.
- Given the hydrogen ion concentration (or concentration of strong acid), calculate the pH; given the pH, calculate the hydrogen-ion concentration.
- Given a proton-transfer reaction, label the Bronsted-Lowry acids and bases, and name the conjugate acid-base pairs.
- Given a Bronsted-Lowry acid-base reaction and the relative strengths of acids (or bases), decide whether reactants or products are favored at equilibrium.
- Decide whether an aqueous solution of a given salt will be acidic, basic, or neutral.
- Given a reaction involving the donation of an electron pair, identify the Lewis acid and Lewis base.

6) Apply the concepts of acid-base theory to the solution of acid-base equilibrium problems.

Potential Elements of the Performance:

- Given the molarity and pH of a solution of a weak acid, calculate the acid ionization constant, Ka. Given Ka, calculate the hydrogen-ion concentration and pH of a solution of a weak acid of known molarity.
- Given the molarity and pH of a solution of a weak base, calculate the base ionization constant, Kb. Given Kb, calculate the hydrogen ion concentration and pH of a solution of a weak base of known molarity.
- Calculate the Ka for a cation or the Kb for an anion from the ionization constant of the conjugate base or acid.
- Given the concentrations of weak acid and strong acid in a solution, calculate the degree of ionization and concentration of the anion of the weak acid
- Given the Ka and the concentrations of weak acid and its salt in a solution, calculate the pH. Given the Kb and the concentrations of weak base and its salt in a solution, calculate the pH.

- Calculate the pH of a given volume of buffer solution (given the concentrations of conjugate acid and base in the buffer) to which a specified amount of strong acid or base is added.
- Calculate the pH during the titration of a strong acid and strong base, given the volumes and concentrations of the acid and base.

III. TOPICS:

1) Reactions and calculations in solution chemistry.
2) Writing and balancing oxidation-reduction equations.
3) Problem solving in gaseous equilibria.
4) Solubility equilibria and solubility product.
5) Acid-base concepts.
6) Problem solving in acid-base equilibria.

LABORATORY WORK

The student will complete five of the experiments designated for this course in the allotted time. The following experiments are required: (#1 to 4 and 3 or 5)

1. Series of chemical reactions
2. Titration of Acids and Bases - standardization of NaOH, and determination of unknown KHP.
3. Gravimetric Cl^- - Cl^- in a known (NH_4Cl) plus Cl^- in an unknown.
4. Volumetric Cl^- - Cl^- in a known (NaCl) and in unknown (use same unknown as Exp. #2)
5. Gravimetric Ni - use organic precipitant DMG.
6. Hardness of water - Volumetric determination using EDTA.

In addition to the above the student will be able to subject his results to statistical analysis and determine:

1. Precision
2. Relative error
3. Average deviation
4. Standard deviation
5. Whether a result should be excluded by the 2.5d rule or 4d rule.

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

TEXT:

Chemistry for Environmental Engineering by Sawyer, McCarty and Parkin, McGraw Hill, 1994.

LAB MANUAL:

Lab Experiments for CHM 211 - Sault College, 2nd ed.

V. EVALUATION PROCESS/GRADING SYSTEM

GRADING:

Grades: >90% - A+
>80% - A
>70% - B
>60% - C

The final grade is calculated by adding the theory marks (50%) and the lab marks (50%).

The lab mark is the sum of all marks awarded for the analysis plus the written report for each of the five experiments. The analysis is graded on accuracy and precision. The report is graded on format, content, and neatness.

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The theory mark is the sum of all tests, assignments, mid-term and final examinations.

Term Test/Quizzes/Assignments/Final Exam	50 marks
Lab Work	50 marks
	100 marks

Assignments are due on the date specified at the beginning of the class. Late assignments will not be accepted so it is critical that you submit as much of the assignment as possible on the due date. Lab reports are due one week from completion of the lab. Late labs will be downgraded 10% per week.

ATTENDANCE:

Your grade will be greatly affected by attendance at scheduled classes and labs. 85% is required at all theory classes while 100% is needed for all labs. Serious illness (doctor's care) is the only valid excuse.

VI. SPECIAL NOTES:

- Special Needs
  If you are a student with special needs (e.g. physical limitations, visual impairments, hearing impairments, learning disabilities), you are encouraged to discuss required accommodations with the instructor and/or contact the Special Needs Office, Room E1204, Ext. 493, 717, 491 so that support services can be arranged for you.

- Retention of Course Outlines
  It is the responsibility of the student to retain all course outlines for possible future use in acquiring advanced standing at other post-secondary institutions.

- While every attempt will be made to accommodate all special learning needs the college should be contacted to discuss these needs before enrolling in any program.

- Substitute Course Information is available at the Registrar's Office.

VII. PRIOR LEARNING ASSESSMENT

Students who wish to apply for advanced credit in the course should consult the instructor. Credit for prior learning may be given if it can be established that all learning outcomes have been met.