

# SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO



## COURSE OUTLINE

**COURSE TITLE:** GENERAL CHEMISTRY - WATER  
**CODE NO. :** CHM211                                  **SEMESTER:** II  
**PROGRAM:** ENVIRONMENTAL TECHNICIAN - WATER  
**AUTHOR:** DAVID TROWBRIDGE  
**DATE:** JAN 2012                                  **PREVIOUS OUTLINE DATED:** JAN 2011

**APPROVED:**

"B.Punch"

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**CHAIR**

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**DATE**

**TOTAL CREDITS:** 5  
**PREREQUISITE(S):** CHM 211  
**HOURS/WEEK:** 3 HOURS LECTURE, 2 HOURS LAB

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**I. COURSE DESCRIPTION:**

General Chemistry begins with a review of the structure of matter, the electronic structure of atoms, the periodic nature of the elements, bonding, Lewis Structures, nomenclature, and chemical reactions. Other topics include chemical calculations, the mole concept, energy changes in chemical reactions, electrochemistry and oxidation-reduction equations, equilibrium in gaseous and aqueous reactions, and introduction to organic chemistry.

A comprehensive workshop on lab techniques and lab safety and on report preparation will be held during the early weeks of the semester in the laboratory class

**II. LEARNING OUTCOMES:**

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

1. State the basic concepts of the atomic structure of matter.
2. Distinguish between atomic, molecular and ionic substances
3. Name chemical substances by common name and IUPAC name.
4. Describe the theory of ions in solution, recognize precipitation, acid-base and gas forming reactions and write ionic and non ionic equations.
5. Explain the mole concept and quantify substances in terms of mass and moles and complete calculations to determine chemical formulas and quantities of substances involved in chemical reactions.
6. Describe and calculate energy changes in chemical reactions
7. Perform calculations involving compounds in aqueous solutions.
8. Write and balance oxidation – reduction equations.
9. Use equilibrium concepts to solve for desired quantities in gaseous and aqueous reactions
10. Apply the concepts of solubility product to solve problems in solubility equilibria.
11. Apply the concepts of acid – base theory to the solution of acid base equilibrium problems.

### III. ELEMENTS OF THE PERFORMANCE

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

- 1) Use the S.I. measurement system and the basic terms commonly found in chemistry.

Potential Elements of the Performance:

- outline the steps in the process known as the scientific method,
- define matter, mass, weight, volume and state their main characteristics,
- state and use the law of conservation of mass to calculate an unknown mass given the other masses in a chemical reaction,
- distinguish between the three states of matter,
- identify physical and chemical changes and properties,
- define the terms substance, element, compound and mixtures and the relationship between them,
- define and use mass, volume, and density to calculate one quantity given the other two,
- describe three commonly used temperature scales and conversions from one to the other,
- identify and explain the workings of measuring devices for the common characteristics of matter,
- perform basic calculations and round off the answer to the correct number of significant digits,
- use the unit-factor method to make conversions within the S.I. system,
- define and calculate the density and specific gravity of various forms of matter.

- 2) State the properties of matter and describe the atomic structure of matter.

Potential Elements of the Performance:

- list the postulates in Dalton's atomic theory,
- state the deductions following from Dalton's theory including the law of multiple proportions,
- identify elements from symbols and give the correct symbol for any element,
- describe the structure of the atom and its fundamental components,
- characterize three major subatomic particles and give one theory on their general arrangement,
- define atomic number and mass number and use these to determine the number of particles in an atom,
- explain the difference in structure of isotopes of an element and the effects on atomic mass
- write nuclide symbols given the atomic and mass numbers,
- define atomic mass, atomic mass units and atomic weight,

- given the isotope mass and fractional abundance calculate the relative atomic weight,
- 3) Distinguish between atomic, molecular and ionic substances

Potential Elements of the Performance:

- define an element, give examples and state their relationship to atoms,
- list the 10 most common elements in the earth's crust and the 6 most common in the human body,
- identify the group and period of elements in the periodic table
- explain the ordering and chemical characteristics of elements based on their position in the periodic table,
- define chemical formula and given a formula, state the identity and number of elements involved,
- describe the type and nature of the chemical bonds that occur in pure substances,
- define and give examples of compounds, ionic substances, molecular compounds, ions and molecules,

- 4) Describe the difference between ionic and covalent bonds.

Potential Elements of the Performance:

- explain the necessary conditions for the formation of each type of bond.
- state the relationship between ionization energy and periodicity.
- write ionic charges for all main group elements.
- use Lewis symbols to depict reactions between elements.
- identify the correct ratios of elements involved in electron transfer reactions.
- use subscripts to correctly express the ratios of atoms in binary compounds.
- write the electrical charges of ions formed from main group elements.
- describe how it can be determined if an atom will gain or lose electrons in a chemical reaction.
- define the term "electronegativity".
- explain how electronegativity varies throughout the periodic table.
- classify compounds as ionic or covalent, based on their electronegativity difference.
- describe what causes a binary molecule to be polar.
- define the term "dipole moment".
- give at least two examples of how the three-dimensional arrangement of a molecule affects its biological function

- 5) Predict the formulas of binary ionic, covalent and ternary compounds.

Potential Elements of the Performance:

- use information from the charges of individual elements to determine how many of each atom is necessary to achieve a net electrical charge of zero in a compound.
- express the previously determined ratio using the necessary subscripts to indicate the relative numbers of atoms in a chemical formula. This may be done via the “cross-over approach” or the net charge approach.

- 6) Construct the names of ionic compounds.

Potential Elements of the Performance:

- name binary compounds formed by elements in the first three periods by writing the name of the metal followed by the name of the nonmetal combined with the suffix “ide”.
- identify cases in which the Stock system must be used to name binary ionic compounds.
- write Stock system names for compounds containing ions with more than one possible charge.
- recall the names of common polyatomic ions.
- write formulas for compounds containing polyatomic ions, using subscripts as needed.
- write names for compounds containing polyatomic ions.
- explain the difference between electrolytes and non-electrolytes.
- name at least three examples of ions in the human body.
- describe the difference between ionic solids and molecules when they are in various physical states.

- 7) Construct the names of covalent compounds.

Potential Elements of the Performance:

- know when a Greek prefix is required in the name of a covalent compound.
- write the names of covalent compounds using Greek prefixes in order to express the ratios of elements in each compound.

- 8) Create Lewis structures.

Potential Elements of the Performance:

- apply the octet rule and information from the periodic table to predict the formula of the product of the reaction between two elements.

- draw Lewis structures that represent the reaction of two elements to form a binary compound.
- explain the difference between bonding pairs and lone pairs.
- simplify Lewis structure into a structural formula.
- identify exceptions to the octet rule.
- draw Lewis structures for molecules with a well-defined central atom.
- draw Lewis structures for simple organic compounds (alkanes).
- write Lewis structures for compounds containing multiple bonds.
- determine when it is necessary to include multiple bonds in a Lewis structure and the appropriate multiplicity (i.e. double, triple) of each bond.
- draw Lewis structures for polyatomic ions, taking their charge into account.
- explain what a coordinate covalent bond is.

8) Perform chemical calculations

Potential Elements of the Performance:

- calculate the formula mass of a compound.
- define the mole.
- use the mole as a unit conversion factor for converting mass into moles and moles into mass.
- state the magnitude of Avogadro's number and what it implies about the size of atoms and molecules and the numbers of them in a weighable sample.
- calculate the empirical and molecular formulas of a compound.
- write a chemical reaction as an equation.
- balance a chemical equation.
- use a balanced chemical equation to predict the masses of compounds produced and used up in a chemical process.

9). Describe the theory of ions in solution; recognize precipitation, acid-base and gas forming reactions and write ionic and non ionic equations.

Potential Elements of the Performance:

- describe how the formation of a solution depends on the molecular properties of the solute and solvents.
- give the quantitative definitions of concentration and use them as conversion factors in calculations.
- specify reasons and methods for preparing dilute solutions from concentrated solutions.
- describe diffusion and the characteristics of semipermeable membranes from a molecular point of view.
- describe the origin of osmotic pressure and how it is measured and used in calculations.

- describe the properties of macromolecules and colloidal solutions.

10. Perform calculations involving compounds in aqueous solutions.

Potential Elements of the Performance:

- Make calculations for preparation of solutions having concentration expressed in moles per Litre or molarity (M), normality (N) and ppm, and be able to convert from one concentration to another.
- 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.

11. 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.

12. 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  $K_c$ .
- Given the concentrations of substances in a reaction mixture, predict the direction of reaction.

- Given  $K_c$  and all concentrations of substances but one in an equilibrium mixture, calculate the concentration of this one substance.
- Given the starting composition and  $K_c$  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.

13. Apply concepts of the 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 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.

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

Potential Elements of the Performance:

- Calculate the pH during the titration of a strong acid and strong base, given the volumes and concentrations of the acid and base.

15. Describe the characteristics of organic compounds and name simple compounds.

Potential Elements of the Performance:

- Identify the main functional groups that are common in organic compounds.
- Name simple organic compounds when given their formula and write names given their name.



**IV. TOPICS**

1. Atoms, Molecules and Ions
2. Chemical Reactions
3. Calculations with Chemical Formulas and Equations
4. Oxidation and Reduction Concepts
5. Acids, Bases and Salts
6. Solubility and Solutions
7. Colloids and Coagulation
8. Ionization Theory
9. Organic Chemistry Introduction

**LABORATORY WORK**

In a laboratory setting, the student will conduct experimental procedures to support the theoretical concepts and these will be selected from the following:

1. Measurement laboratory.
2. Determine the density of an unknown solid and liquid using gravimetric (weighing) technique.
3. Separate an unknown in nature into its components based on differences in physical properties.
4. Determine the mass percentage of water in a compound and calculate the formula of an unknown compound.
5. Conduct chemical reactions and identify the products formed from the given reactants.
6. Determine the chemical formula of a compound formed in a chemical reaction based on mass and moles.
7. Recover a mass of a substance which has been subjected to a sequence of chemical reactions.
8. Titration of acids and bases, standardization and determination of an unknown acid.
9. Gravimetric determination of a chloride.
10. Volumetric determination of an unknown chloride.
11. Spectrophotometric determination in aqueous solution.

**V. REQUIRED RESOURCES/TEXTS/MATERIALS:**

Basic Chemistry for Water and Wastewater Operators by D. S. Sarai, AWWA 2005

Lab Materials: Lab Coat, Safety Glasses

**VI. EVALUATION PROCESS/GRADING SYSTEM**

The following semester grades will be assigned to students in postsecondary courses:

Grade	Definition	Grade Point Equivalent
A+	90 – 100%	
A	>80 % - <90%	4.00
B	>70% - <80%	3.00
C	>60% - <70%	2.00
D	>50% - <60%	1.00
F (Fail)	<50%	0.00
CR (Credit)	Credit for diploma requirements has been awarded.	
S	Satisfactory achievement in field /clinical placement or non-graded subject area.	
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.	
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.	
NR	Grade not reported to Registrar's office.	
W	Student has withdrawn from the course without academic penalty.	

The final grade is calculated by adding the test marks (60%) and the term marks (40%).

The test marks are the sum of three tests worth (Test 1 and 2 - 15% each, Test 3 (covering whole year's material) - 30%).

The term mark is the sum of all marks awarded for labs assignments and quizzes. Labs usually include an analysis plus a written report for each of the experiments. The analysis is graded on accuracy and precision. The report is graded on format, content, and neatness.

Term Tests	60 marks
Lab Work /Quizzes/Assignments	<u>40 marks</u>
	100 marks

**SUBMISSION EXPECTATIONS:**

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. All labs are compulsory. Lab reports are due one week from completion of the lab. Late labs will be downgraded 20% per week from the agreed due date. (See details below regarding missed labs)

**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 medical slip) or absences for compassionate reasons are the exceptions allowed.

Each laboratory activity requires a pre-lab assignment in which the student will familiarize him/herself with the procedure, equipment and safety concerns. This will include researching the hazards and precautions for each chemical used in the lab as described in the Material Safety Data Sheets (MSDS) to be found in the chemistry lab.

A pre-lab lecture will discuss the theoretical and practical aspects of the lab and identify any safety precautions. Consequently attendance at these pre-lab lectures is mandatory and any student missing this lecture must prepare a step by step procedure which also must identify all safety concerns before you will be allowed to begin the lab.

Labs missed without prior agreement of the instructor will be give a **maximum of 50%** of the lab mark once completed to the instructor's satisfaction.

**VII. SPECIAL NOTES:****Course Outline Amendments:**

The professor reserves the right to change the information contained in this course outline depending on the needs of the learner and the availability of resources.

**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 postsecondary institutions.

**Prior Learning Assessment:**

Students who wish to apply for advance credit transfer (advanced standing) should obtain an Application for Advance Credit from the program coordinator (or the course coordinator regarding a general education transfer request) or academic assistant. Students will be required to provide an unofficial transcript and course outline related to the course in question. Please refer to the Student Academic Calendar of Events for the deadline date by which application must be made for advance standing. Credit for prior learning will also be given upon successful completion of a challenge exam or portfolio.

Substitute course information is available in the Registrar's office.

**Disability Services:**

If you are a student with a disability (e.g. physical limitations, visual impairments, hearing impairments, or learning disabilities), you are encouraged to discuss required accommodations with your professor and/or the Disability Services office. Visit Room E1101 or call Extension 2703 so that support services can be arranged for you.

**Communication:**

The College considers WebCT/LMS as the primary channel of communication for each course. Regularly checking this software platform is critical as it will keep you directly connected with faculty and current course information. Success in this course may be directly related to your willingness to take advantage of the Learning Management System communication tool.

**Plagiarism:**

Students should refer to the definition of “academic dishonesty” in Student Code of Conduct. A professor/instructor may assign a sanction as defined below, or make recommendations to the Academic Chair for disposition of the matter. The professor/instructor may (i) issue a verbal reprimand, (ii) make an assignment of a lower grade with explanation, (iii) require additional academic assignments and issue a lower grade upon completion to the maximum grade “C”, (iv) make an automatic assignment of a failing grade, (v) recommend to the Chair dismissal from the course with the assignment of a failing grade. In order to protect students from inadvertent plagiarism, to protect the copyright of the material referenced, and to credit the author of the material, it is the policy of the department to employ a documentation format for referencing source material.

**Student Portal:**

The Sault College portal allows you to view all your student information in one place. mysaultcollege gives you personalized access to online resources seven days a week from your home or school computer. Single log-in access allows you to see your personal and financial information, timetable, grades, records of achievement, unofficial transcript, and outstanding obligations. Announcements, news, the academic calendar of events, class cancellations, your learning management system (LMS), and much more are also accessible through the student portal. Go to <https://my.saultcollege.ca>.

**Electronic Devices in the Classroom:**

Students who wish to use electronic devices in the classroom will seek permission of the faculty member before proceeding to record instruction. With the exception of issues related to accommodations of disability, the decision to approve or refuse the request is the responsibility of the faculty member. Recorded classroom instruction will be used only for personal use and will not be used for any other purpose. Recorded classroom instruction will be destroyed at the end of the course. To ensure this, the student is required to return all copies of recorded material to the faculty member by the last day of class in the semester. Where the use of an electronic device has been approved, the student agrees that materials recorded are for his/her use only, are not for distribution, and are the sole property of the College.

**Attendance:**

Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session.

**Tuition Default:**

Students who have defaulted on the payment of tuition (tuition has not been paid in full, payments were not deferred or payment plan not honoured) as of the first week of March will be removed from placement and clinical activities. This may result in loss of mandatory hours or incomplete course work. Sault College will not be responsible for incomplete hours or outcomes that are not achieved or any other academic requirement not met as of the result of tuition default. Students are encouraged to communicate with Financial Services with regard to the status of their tuition prior to this deadline to ensure that their financial status does not interfere with academic progress.