Revised June, 1986

SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: PRINCIPLES OF CHEMISTRY I

Code No.: CHM 104-4

Program: WATER RESOURCES AND PULP & PAPER ENGINEERING TECHNOLOGY

Semester: ONE

Date: MAY 1984

Author: J. KORREY / D. HEGGART

New: ________ Revision: X

APPROVED: ________ Nov 6/85
Chairperson Date

PRINCIPLES OF CHEMISTRY I	CHM 104-4
Course Name	Course Number

PHILOSOPHY/GOALS:

An introductory course in Chemistry which deals with the structure of matter, electronic structure of atoms, periodic nature of the elements, bonding, nomenclature, equations, solubility and stoichiometry of solutions.

A comprehensive Workshop on report writing will be held during the second week of the semester.

METHOD OF ASSESSMENT (GRADING METHOD):

Theory	50		A = 80 - 100%
Lab	50		B = 70 - 79%
	100		C = 60 - 69%
			I = Less than 60%

The theory grade is the sum of all tests and assignments. Tests will include all work up to the time of each test. All students having 70% or more on term work ar exempt from the final exam which will cover the whole course and counts 20% of the theory grade.

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.

TEXTBOOK(S):

Ebbing, Darrell D., General Chemistry, Houghton Mifflin Co., 1984.

CHM 104

PRINCIPLES OF CHEMISTRY 1

Principles of Chemistry is taught to students in the Water Resources and Pulp & Paper Technology programs in both the first and second semesters.

CHM 104 is taught in the first semester of the program and is a pre-requisite for CHM 218 which is a continuation of Principles of Chemistry theory in Semester 2. CHM 218 can be taken upon successful completion of CHM 104 or with prior approval of the instructor.

CHM 104 consist of four hours per week, two hours being devoted to theory and two hours spent on laboratory work.

UNIT I: ATOMIC THEORY: PURE SUBSTANCES AND MIXTURES, NOMENCLATURE

1.1 Atoms, Molecules, and Ions
- Atoms
- Molecules and Molecular Substances
- Ions and Ionic Substances
- A Word on Naming Substances
- Chemical Reactions
- Nomenclature 7.10, 7.11

1.2 Oxidation Numbers

1.3 Naming Simple Compounds
- Binary Compounds
- Acids
- Ionic Substances

1.4 Balancing Simple Chemical Equations

1.5 Classification of Matter
- Chemical Constitution - Element, Compound, or Mixture?
- Physical State - Solid, Liquid or Gas?

1.6 Separation of Mixtures
- Filtration
- Distillation
- Chromatography

UNIT II: CALCULATIONS WITH CHEMICAL FORMULAS AND EQUATIONS

2.1 Atomic Weights

2.2 Formula Weights

2.3 The Mole Concept
- Definition of Mole
- Mole Calculations

2.4 Mass Percentages from the Formula

2.5 Elemental Analysis

2.6 Determining Molecular Formulas
- Empirical Formula from Elemental Composition
- Molecular Formula from Empirical Formula

2.7 Molecular Interpretation of a Chemical Equation

UNIT II - Continued

2.8 Stoichiometry of a Chemical Reaction

2.9 Limiting Reactant; Theoretical and Percentage Yields

2.10 Molar Concentration

2.11 Diluting Solutions

2.12 Stoichiometry of Solution Reactions

UNIT III: ATOMIC STRUCTURE: ELECTRON CONFIGUATIONS AND PERIODICITY

3.1 The Bohr Theory of the Hydrogen Atom
Atomic Line Spectra
Bohr's Postulates

3.2 Quantum Mechanics

3.3 Quantum Numbers and Atomic Orbitals

3.4 Electron Spin and the Pauli Exclusion Principle
Electron Configurations and Orbital Diagrams

3.5 Building-Up Principle (Aufbau Principle)

3.6 Hund's Rule; Paramagnetism

3.7 Periodic Classification of the Elements
Predictions from the Periodic Table
Arrangement of the Elements by Atomic Number
Relationship to Electron Configurations

3.8 Some Periodic Properties
Atomic Radius
Ionization Energy
Electron Affinity

3.9 A Brief Description of the Main-Group Elements
Group 1A - 8A
Valence-Shell Configurations

UNIT IV: IONIC AND COVALENT BONDING

4.1 Describing Ionic Bonds
Lewis Electron-Dot Symbols
Energy Involved in Ionic Bonding

UNIT IV - Continued

UNIT V: MOLECULAR GEOMETRY AND CHEMICAL BONDING THEORY

COURSE OUTLINE

CHM 104

PRINCIPLES OF CHEMISTRY 1

LABORATORY

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1. Weighing Operations, Densities of Liquids and Solids

2. Separation of the Components of a Mixture

3. Formula of Hydrate

4. Chemical Reactions

5. Chemical Formulas

6. A Sequence of Chemical Reactions

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OBJECTIVES

FOR

CHM 104-4

PRINCIPLES OF CHEMISTRY I

Revised: August, 1983

J.S. Korrey

Unit IV: The nature of Electrons in the Atom

Ref: Chapter 4, Malone, Leo J.

After completion of this chapter, the student should be able to:

1. Distinguish between a continuous spectrum and a discrete spectrum.

2. Describe the meaning of the wave nature of light and the meaning of wavelength.

3. Describe the relationship between energy, frequency and wavelength of light.

4. Draw a diagram and give an explanation of the Bohr model of the hydrogen atom.

5. State the letter, quantum number disignation, and capacity of the first five shells.

6. State the letter, quantum number designation and capacity of the four subshells.

7. Describe how the electrons in each shell are distributed among the subshells.

8. Give the expected electron notation of each element by its position in the periodic table.

9. Describe what is meant by an orbital.

10. Explain the meaning of electron spin and the Pauli Exclusion Principle.

11. Predict which elements are paramagnetic and which are diamagnetic.

12. Predict the number of unpaired electrons in an atom by the use of Hund's rule of maximum multiplicity.

13. Describe the shape of "S" and "p" orbitals.

14. Explain the Aufbau principle and be able to apply it to the electrons of any element.

Unit II: Math & Measurements in Chemistry

Ref: Chapter 2 - Malone, Leo J.

After completion of this unit, the student should be able to:

1. State how many significant figures are in a measurement.

2. State the difference between accuracy and precision.

3. Express the result of a mathematical operation to the proper decimal place (addition & subtraction) or to the proper number of significant figures multiplication and division).

4. Write numbers in scientific notation.

5. Carry out mathematical operations with numbers in scientific notation (review in Appendix-C in text).

6. Distinguish between mass and weight.

7. Write down the principal metric (or SI) Units and their symbols as shown in table 2-1 in text.

8. Give the meaning of the prefixes for metric units listed in Table 2-2 in the text.

9. Convert units used in Chemistry from English to Metric and vice versa using the unit-factor method.

10. State the meaning of the terms density, buoyancy and specific gravity.

11. Use Density as a conversion factor between Weight and Volume.

12. Convert temperatures in degrees Fahrenheit to Celsius degrees and vice versa.

Unit 1:

Ref: Chapter 1 - Malone, Leo J., Basic Concepts of Chemistry

After Completion of this chapter, the student should be able to:

1. Give a definition of Chemistry.
2. Describe the three physical states of matter.
3. State the difference between homogeneous and heterogenous matter and give examples of each.
4. Describe the difference between a mixture, a solution and a pure substance.
5. Describe the difference in properties between a mixture and a pure substance.
6. Explain what is meant by the terms elements and compounds.
7. State the symbols and names of the first 20 common elements.
8. Describe physical and chemical properties and physical and chemical changes.
9. Know the meaning of the law of Conservation of mass and Conservation of energy.
10. Know the various forms of Energy.
11. State the difference between potential and kinetic energy.
12. State the relationship between matter and energy.

Unit III: The Structure of Matter, The Nucleus and Nuclear Reactions

Ref: Chapter 3, Malone, Leo J.

After completion of this chapter, the student should be able to:

1. Describe the difference between an atom and a molecule.
2. Describe the function of a chemical bond.
3. Write the meaning of the formula of a compound.
4. State the meaning of an ion, an ionic compound, and electrostatic forces.
5. Explain the nuclear concept of the atom.
6. Describe the location, mass (in A.M.U.). and electrical change of electrons, protons, and neutrons in an unchanged atom.
7. Determine the number of protons, neutrons, and electrons in an unchanged atom or ion.
8. Illustrate the relationship of atomic number and mass number to the number of protons, neutrons and electrons.
9. Describe how the atomic weight of an element is determined.

Unit V: The Periodic Nature of the Elements

Ref: Chapter 5 - Malone, Leo J.

After completion of this chapter, the student should be able to:

1. Explain the origin and purpose of the periodic table.

2. Locate metals, non-metals and metalloids in the periodic table.

3. Explain what is meant by a period and a group.

4. Give the location and electron notation characteristics of the four Bohr groups.

S. State the location of the seven groups of the representative elements.

6. Predict the periodic trends of elements in the periodic table and state the reason for the following trends:

   a) atomic radii
   b) ionization energy
   c) electron affinity

Unit VI: The nature of bonding

Ref: Chapter 6 - Malone, Leo J.

After completion of this chapter, the student should be able to:

1. State the meaning and give examples of the octet rule.

2. Write Lewis dot structures for any representative element.

3. Determine the charge on representative metal cations and non-metal anions.

4. Determine the formula of binary ionic compounds of the representative elements.

5. Describe how covalent bonding occurs and state which elements combine in this manner.

6. Write Lewis dot structures of simple binary molecules containing single, covalent bonds.

7. Describe how double and triple covalent bonds are formed.

8. Write the Lewis structures of molecules and ions containing multiple bonds.

9. Explain the meaning of resonance hybrids and what they represent.

10. Define what is meant by a polar covalent bond and explain how it differs from a nonpolar and an ionic bond.

11. Explain how the electronegativities of atoms influence the polarity of the bond and the direction of the dipole.

12. Explain/illustrate how the geometry of a molucule affects its overall or net polarity.

Unit VII: The naming of Compounds

Ref: Chapter 7 - Malone, Leo J.

After completion of this chapter, the student should be able to:

1. Determine the oxidation state of an element in a compound.

2. Name metal - non metal binary compounds.

3. List the metals which have only one oxidation state.

4. Name metals with variable oxidation states by older methods as well as the stock method.

5. a) Write the names and formulas of all polyatomic ions listed in table 7-3 (the charge must be correct).

   b) name compounds with polyatomic ions.

6. Name nonmetal - nonmetal binary compounds by use of Greek prefixes listed in table 7-4.

7. Name binary and oxyacids.

8. Write formulas for the compounds listed in objectives 2, 5(b) 6, and 7.

Unit VIII: Quantitative Relationships - The Mole

Ref: Chapter 8 - Malone, Leo J.

After completion of this chapter, the student should be able to:

1. Give a definition of The Mole.
2. State Avogadro's number of particles corresponding to a mole.
3. Find the mass of one mole of an element (molar mass) from the periodic table.
4. Convert between moles, mass and number of atoms of an element.
5. Calculate the formula mass of a compound.
6. Discuss the relationship between the molar mass of a compound and the number of molecules.
7. Convert between moles, mass, and number of molecules or formula units of a compound.
8. Calculate the percent composition of the elements in a compound.
9. Determine the empirical formula of a compound from analytical data.
10. Describe the difference between the empirical and molecular formula of a compound.
11. Solve problems similar to the fourteen examples shown in this chapter.

Unit IX: Quantitative Relationships - The chemical equation

Ref: Chapter 9 - Malone, Leo J.

After completion of this chapter, the student should be able to:

1. Interpret the meanings of balanced equations.

2. Write and balance simple chemical equations.

3. Distinguish between the five main types of chemical reactions listed in the text.

4. Calculate the amount of another substance needed or produced in a reaction, from the amount of one substance taking part in a reaction and the balanced equation (units of amount may be in moles, grams, and/or number of particles).

5. Calculate the percentage yeild in a chemical reaction knowing the amount of each reactant and the actual yield.

6. Determine which reactant is the limiting reactant and reactant in excess in a balanced chemical equation knowing the amount of each reactant.

Unit X: Solution Problems

Ref: Chapter 11, sections 5, 6 and 7, Malone, Leo J.