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CURRICULUM GUIDE: OFFICIAL COURSE OUTLINE

Course Code	CHEM 102	Course Title	Principles of Chemistry II			
Credit Value	4	Department	Mathematics and Science			
No. of weeks	14	Hrs. per week	*Lecture*	*Tutorial*	*Laboratory*	*Total*
			3	0	3	6
Course Description	This laboratory-lecture course is designed for students who want to pursue a major or minor degree program in science. The course introduces the principles of chemistry with emphasis on Organic Chemistry, Chemical Kinetics, Thermodynamics, Dynamic equilibrium, Acid and Bases, and Electrochemistry. The course consists of lectures, tutorials, and integrated laboratory experiments.					
Prerequisite(s)	ENGL 098, CHEM 101					

Initial Articulation Targets	*UBC*	*SFU*	*UVic*	*UNBC*	*TRU*
	CHEM_V 1st (4); ALEX CHEM 101 (4) & ALEX CHEM 102 (4) = UBCV CHEM_V 121 (4) & UBCV CHEM_V 123 (4)	CHEM 122 (2) & CHEM 126 (2), Q	CHEM 1XX (1.5); ALEX CHEM 101 (4) & ALEX CHEM 102 (4) = UVIC CHEM 101 (1.5) & UVIC CHEM 102 (1.5)	CHEM 1XX (4); ALEX CHEM 101 (4) & ALEX CHEM 102 (4) = UNBC CHEM 100 (3) & UNBC CHEM 101 (3) & UNBC CHEM 120 (1) & UNBC CHEM 121 (1)	CHEM 1500 (3)
	For updated information on the transferability of this course, please consult the BC Transfer Guide, www.bctransferguide.ca				

Learning Outcomes

Upon successful completion of this course, the student will be able to:

- Identify the main functional groups in organic chemistry.
- Name organic compounds according to IUPAC notation.
- Draw the reaction mechanism for addition, substitution, and elimination reactions.
- List optimum conditions for addition, substitution. and elimination reactions.
- Explain chemical reaction at macroscopic and microscopic level.
- Explain the correlation between of ΔG, ΔH, ΔS.
- Identify exothermic and endothermic reactions and calculate Ea.
- Describe the dependence of reaction rate on factors such as temperature, concentration, surface area.
- Explain the mechanism of a reaction and describe its reaction rate.
- Utilize the integrated rate laws to determine concentrations of reaction species.
- Define the nature of chemical equilibrium.

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	• Determine the equilibrium constant of a reaction and the ion concentration of all ions involved in an equilibrium reaction. • Explain how the equilibrium position is affected by concentration, pressure, temperature. • Predict the direction of a chemical reaction based on the reaction quotient (Q) value. • Describe Bronsted-Lowry acids and bases including conjugated acid-bases pairs. • Compare and contrast the characteristics of strong and weak acids/bases. • Calculate [H+], [OH-], pH, and pOH of acids and bases according to their strength. • Predict the pH of a salt solution. • Describe the characteristics of a buffer system. • Calculate the pH of a buffer and the concentrations needed to compose a buffer with a set pH. • Calculate the concentration of strong and weak acids through titration. • Calculate the concentration of species of precipitation and complexation reactions. • Assign oxidation states to elements in compounds. • Identify oxidizing and reducing agents. • Balance redox equations. • Describe a galvanic cell notation from a redox reaction and vice versa. • Calculate cell potentials for non-standard conditions using the Nernst equation.
Content	**Core** topics – all of the following will be covered: Review of Chemical Kinetics • Rates of reaction • Rate equations • Effect of temperature on reaction rates • Reaction mechanisms and relationship to rate equations Chemical Equilibria • Inter-relationship of Kp and Kc • Ionic equilibria: dissociation of weak electrolytes and related calculations • Ionization of water, Kw and pH, pOH • Titrations of acids/bases, and pH titration curves • Indicators, common ion effect, buffers • Ionization of polyprotic acids • Solubility products • Arrhenius, Bronsted-Lowry and Lewis theories of acids and bases Thermodynamics II (continued from Chem 101) • Second Law - changes in entropy of system and universe • Gibbs Free energy, ΔG • Effect of ΔG, ΔH, ΔS on spontaneity of a reaction and position of equilibrium • Relationship between ΔG and equilibrium constants • Thermodynamics of redox reactions and the Nernst equation • Absolute entropy; the Third Law

	Electrochemistry
	• Redox reactions
	• Electrochemical cells, half-reactions, reduction potentials
	• Cell potential, Nernst equation
	
	Organic Chemistry
	• Hydrocarbons and Alkanes: Rotational conformations
	  ○ Mechanism of halogenation
	  ○ Homolytic and heterolytic bond fission
	  ○ Cyclohexane and conformations of cyclic alkanes
	• Functional Groups: Nomenclature, structure, and trends
	  ○ Bonding and hybridization
	  ○ Sigma and pi bonds
	• Isomers
	  ○ Structural and stereo isomers
	  ○ Positional isomerism, functional group isomerism, geometric isomerism
	  ○ Chirality, configuration, E/Z and R/S naming
	  ○ Optical isomers
	  ○ Fischer projections
	• IUPAC Nomenclature
	  ○ Alkyl halides: Preparation
	  ○ Introduction to organic reactions
	  ○ Nucleophilic substitution
	  ○ SN1 and SN2 mechanisms
	  ○ Competition with elimination processes
	
	Additional topics may also be covered, at the discretion of the instructor.
	
	Labs (8 from the following list):
	• Bleach analysis
	• Preparation of soap
	• Determination of potentials of voltaic cells
	• Determination of an equilibrium constant
	• Le Chatelier's principle
	• Preparation of buffer solution and determine their pH values
	• Aspirin synthesis and analysis
	• Molar solubility: the common-ion effect
	• Factors affecting reaction rates
	• Determination of a rate law and activation energy
	• Thermodynamics of neutralization reactions

Methods of Instruction	Lectures, group discussions, problem solving, hands-on labs, quizzes, assignments, labs, simulations

<table>
<tr><td>Required Textbook(s)</td><td colspan="3">The following textbook(s) is/are required, or approved equivalent(s).

Ball, David W and Jessie A. Key. Introductory Chemistry – 1st Canadian Ed. Open Textbook Library, 2014.

Flowers, Paul, et al. Chemistry. 2nd Ed. OpenStax, 2022.

Olmsted, John A. et al. Chemistry. 4th Canadian Edition. Wiley, 2021.</td></tr>
<tr><td>Required Equipment and Technology</td><td colspan="3">Students are required to have a computer with internet access.
The following resources are provided by the College:
• Office 365
• Student email</td></tr>
<tr><td>Homework Hours</td><td colspan="3">At minimum, students can expect one hour of homework for every hour of instructional time.</td></tr>
<tr><td rowspan="4">Evaluation</td><td>Component</td><td colspan="2">% Value</td></tr>
<tr><td>Quizzes and assignments
Laboratory experiments and activities
• Weight divided over 8 labs
Midterm exam (2)
Comprehensive final exam</td><td colspan="2">10-15%
15-20%

30-40%
30-35%</td></tr>
</table>

Completion Requirements	The minimum grade to pass this course is D (50%). Unless otherwise stated, a minimum grade of C- (55%) is required for this course to fulfil a prerequisite.		
Course Designer(s)	Lesley Spier, Ph.D., and Nigel S. Dance, Ph.D., Department of Chemistry, University of the Fraser Valley	Consultant(s), *if applicable*	
Dean's Approval	Barbara Moon, Ph.D., Dean of Arts and Sciences, Alexander College	Dean's Approval Date	September 29, 2010
Curriculum Committee Approval Date	September 29, 2010	First Term Offered	Fall 2011
Last Review Date	September 1, 2024	Next Review Date	September 1, 2029
Revision History	June 30, 2015-CHEM 100 Prerequisite added by Barbara Moon. June 30, 2016-CHEM 100 prerequisite added by Barbara Moon, Dean of Arts and Sciences January 24, 2020-Review and minor revision or topics, texts, and evaluation weighting by Jason Mirzei, Ph.D. and Miriam Grob, Ph.D. faculty, Chemistry discipline, Alexander College, and Patrick Duffy, Ph.D. Department of Chemistry, Kwantlen Polytechnic University March 1, 2023-Minor updates (e.g., assessment ranges, textbooks) by Jason Mirzaei, Miriam Grob, and Patrick Duffy. September 1, 2024. Lab assignments and assessments detailed by Kelly Cheung.		

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