



**UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF CHEMISTRY  
COURSE SYLLABUS  
FALL 2017**

1. **Course:** Chemistry 203, General Chemistry: Change and Equilibrium

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	11:00-11:50	SB 103	Dr. Yuen-ying Carpenter	EEEL 237B	<a href="mailto:yyscarpe@ucalgary.ca">yyscarpe@ucalgary.ca</a>	TBA
L02	MWF	12:00-12:50	SB 103	Dr. Yuen-ying Carpenter	EEEL 237B	<a href="mailto:yyscarpe@ucalgary.ca">yyscarpe@ucalgary.ca</a>	
L03	TuTh	8:00-9:15	SB 103	Dr. Violeta Iosub	SA 144C	<a href="mailto:viosub@ucalgary.ca">viosub@ucalgary.ca</a>	

**Course, Lab, and Tutorial coordinator:** Dr. Yuen-ying Carpenter (EEEL 237B | [yyscarpe@ucalgary.ca](mailto:yyscarpe@ucalgary.ca))

Course website: [d2l.ucalgary.ca](http://d2l.ucalgary.ca) [CHEM 203 - (Fall 2017) - General Chemistry: Change and Equilibrium]

Departmental Office: Room SA 229 | Tel: 403-220-5341 | e-mail: [chem.undergrad@ucalgary.ca](mailto:chem.undergrad@ucalgary.ca)

To avoid IT problems, it is recommended that the students use their U of C account for all course correspondence. Please include 'CHEM 203' in the subject line of your email.

2. **Course Description:** An introduction to university chemistry from theoretical and practical perspectives that focuses on an exploration of the fundamental links between kinetics, equilibria and thermodynamics and explores acidity/basicity and redox behaviour using inorganic and organic examples.
3. **Recommended Textbook(s):** *Chemistry and Chemical Reactivity*, Ninth Edition by J.C. Kotz, P.M. Treichel and J.R. Townsend, Brooks/Cole, CENGAGE Learning, 2015 (available in print or electronic form), plus printed access code for eLibrary and the Student Solutions Manual.
4. **Course learning objectives and associated textbook references:**  
Please note: Not all sub-sections of each textbook chapter will necessarily be covered

Enduring Understandings	Learning Objectives
<b>Gases and Stoichiometry</b>	
<i>Chapter 10 and Review chapters 1-4</i>	
<p>To determine what is happening quantitatively in chemical reactions one must use the principles of stoichiometry.</p> <p>Gases are good systems for understanding molecular behaviour and its relationship to properties such as temperature and pressure..</p>	<p><i>Review:</i> Interpret, predict, and write formulas for chemical species.</p> <p><i>Review:</i> Identify, generate and balance chemical equations.</p> <p><i>Review:</i> Identify limiting and excess reactant(s) and use them to calculate theoretical and percent yields.</p> <p><i>Review:</i> Interconvert between concentrations, moles and masses of chemical species in solution.</p> <p>Use the ideal gas law to do stoichiometric calculations involving gases.</p> <p>Interconvert between partial pressures, mole fractions of gases with and total pressure of a gaseous system.</p> <p>Describe the Kinetic Molecular theory of gases (KMT). Use this model to explain relationships between temperature and particle speeds. Use this model to explain why pressure varies as n, V and T are altered.</p> <p>Describe the limitations of the ideal gas law</p>

Enduring Understandings	Learning Objectives
<b>Equilibrium</b> <i>Chapter 15</i>	
<p>Most reactions attain a state of dynamic equilibrium.</p> <p>The reaction quotient is used to determine the progress or extent of a reaction mixture.</p> <p>The extent of a reaction can be altered by changing the conditions of a system.</p>	<p>Sketch and interpret graphs that qualitatively describe dynamic equilibria.</p> <p>Calculate equilibrium constants from experimental data. Calculate equilibrium concentrations based on initial conditions and <math>K_{eq}</math>.</p> <p>Write K/Q expressions for an equilibrium reaction.</p> <p>Use K and Q values to predict the direction of a reaction for a given set of reaction conditions (concentrations, P's, T etc.).</p> <p>Qualitatively predict changes to a system at equilibrium resulting from adding a common ion or changing concentration, P, V or T.</p>
<b>Thermodynamics</b> <i>Chapters 5 and 18</i>	
<p>Chemical changes usually involve energy changes.</p> <p>Reaction coordinate diagrams give a visual representation of the energy changes during a chemical change.</p>	<p>Define the terms system, surrounding and universe as applied to a chemical change.</p> <p>Identify standard states of common chemical compounds.</p> <p>Define enthalpy of formation and bond dissociation enthalpy, and use these values to determine or estimate enthalpy change for a reaction.</p> <p>Relate the enthalpy change for a chemical process to the heat released/absorbed during that process.</p> <p>Relate the specific heat of a substance to the temperature change when heat is produced, absorbed, or transferred.</p> <p>Calculate the pressure-volume work done by or on a system.</p> <p>Relate changes in the internal energy of a system to the work done by/on the system and the heat released/absorbed by the system.</p> <p>Generate and use reaction coordinate diagrams to explain the energy changes that occur during a chemical change.</p>
<p>Enthalpy and entropy changes both contribute to the free energy change of any chemical change.</p> <p>The free energy change of a chemical change can be used to determine its spontaneity.</p> <p>The spontaneity of chemical changes can be varied by changing conditions.</p> <p>The spontaneity of chemical changes relates to the extent of the reaction.</p>	<p>Define and determine qualitatively and quantitatively the enthalpy and entropy changes for a chemical change.</p> <p>Qualitatively and quantitatively relate enthalpy and entropy to the free energy or spontaneity of a chemical change.</p> <p>Qualitatively and quantitatively examine the temperature at which spontaneity changes.</p> <p>Interconvert between <math>\Delta_rG</math>, <math>\Delta_rG^\circ</math>, <math>Q</math> and <math>K</math>.</p>
<b>Kinetics</b> <i>Chapter 14</i>	
<p>The rate law is used to quantitatively examine the rate of a reaction.</p> <p>The rate of a reaction can be altered by changing the conditions of a system.</p>	<p>Distinguish between average and instantaneous rates of reaction based on graphs of concentration vs. time.</p> <p>Use graphs of concentration vs. time to compare rates and rate laws for different reactions.</p> <p>Determine the differential and/or integrated rate laws for a given reaction using experimental data.</p> <p>Predict the change in the rate of reaction that results from changing reactant concentrations or temperature, or from the addition of a catalyst.</p>

Enduring Understandings	Learning Objectives
<p>Rates can be explained at a molecular-level using collision theory.</p> <p>Reactions can occur via a series of steps or a mechanism.</p> <p>Reaction coordinate diagrams provide a representation of the energy changes that influence rate.</p> <p>Catalysts provide alternative mechanisms, thereby altering the energy changes and rates for a reaction.</p>	<p>Use collision theory to qualitatively explain differing reaction rates.</p> <p>Use the Arrhenius equation to quantify the relationships between the activation energy, temperature and rate constant.</p> <p>Describe the concept of a reaction mechanism and identify reasonable reaction mechanisms consistent with the experimentally-determined rate law for a given reaction.</p> <p>Identify the rate-determining step, intermediates and catalysts present in a given reaction mechanism.</p> <p>Identify plausible reaction coordinate diagrams based on information about a reaction mechanism.</p> <p>Label key kinetic components of a reaction coordinate diagram for a chemical change (<i>i.e.</i> transition state, intermediate, activation energy).</p> <p>Describe the effect of a catalyst on the activation energy of a reaction.</p>
<b>Applying Chemical Equilibria: Acids &amp; Bases</b> <span style="float: right;"><i>Chapter 16 and Chapter 17-1 to 17-3</i></span>	
<p>The pH of an aqueous solution of an acid or base is determined by both concentration and the extent of their reaction with water.</p> <p>Weak acids and bases are used to prepare buffer solutions that are used to resist changes in pH.</p> <p>Titration experiments are important for studying acids and bases.</p>	<p>Distinguish between <math>K</math> and <math>pK</math> and relate these values to acid/base strength and to hydronium ion concentrations <math>[H_3O^+]</math> in solution.</p> <p>Quantitatively relate <math>K_a</math>, <math>pK_a</math>, <math>K_b</math>, <math>pK_b</math>, pH, <math>[H_3O^+]</math> and <math>[OH^-]</math>.</p> <p>Calculate the pH for an acid or a base in aqueous solution.</p> <p>Describe how a buffer functions and outline how to prepare a buffer with a given pH.</p> <p>Calculate the pH of a buffer solution before and after the addition of strong acids or bases.</p> <p>Qualitatively compare the acid or base buffer capacities of solutions.</p> <p>Distinguish between the titration of strong acids/bases and the titration of weak acids/bases.</p> <p>Qualitatively and quantitatively describe how pH varies during a titration by identifying the major and minor species in solution at each stage.</p> <p>Use titration to determine the identity of an acid or base.</p>
<b>Applying Chemical Equilibria: Solubility</b> <span style="float: right;"><i>Chapter 17-4 to 17-5</i></span>	
<p>The solubility of salts in aqueous solution is related to their extent of dissociation in water.</p>	<p>Qualitatively and quantitatively relate the solubility of salts to <math>K_{sp}</math>.</p> <p>Predict how the solubility of a salt will be affected by changing conditions.</p>
<b>Applying Equilibria and Thermodynamics: Electrochemistry</b> <span style="float: right;"><i>Chapter 19</i></span>	
<p>An electrochemical cell provides a means to generate an electric potential from a redox reaction.</p> <p>The electrical potential generated by an electrochemical cell is related to the spontaneity and extent of the redox reaction.</p>	<p>Describe the components of an electrochemical cell.</p> <p>Generate or identify the electrochemical cell for a given redox reaction.</p> <p>Compare standard and non-standard cell potentials by qualitatively predicting how the cell voltage will change with concentration.</p> <p>Relate the cell voltage (<math>E^\circ_{cell}</math>) and free energy (<math>\Delta_rG^\circ</math>) of reactions under standard conditions to the equilibrium constant (<math>K</math>) for a redox reaction.</p>

**5. Laboratory Experiments:** (5 experiments on alternate weeks, 3 hours in laboratory biweekly, *see schedule*)

Experiment 1. I can't believe it's soap

Experiment 2. Determining the equilibrium constant for the formation of ferric thiocyanate,  $\text{Fe}(\text{SCN})_2^+$

Experiment 3. Investigation into the kinetic behaviour of aqueous phenolphthalein solutions

Experiment 4. Identification of an unknown acid by titration

Experiment 5. Preparation of a buffer solution & investigation of its properties

**6. Tutorials:** (5 tutorials on alternate weeks, 1.25 hours in tutorials biweekly, *see schedule*)

Bi-weekly tutorial topics include:

- Gas laws and stoichiometry
- Enthalpy, heat, and work
- Equilibrium
- Kinetics
- Acid and Base Solutions

Department Approval: Approved by Department Head

Date: September 5, 2017

**Schedule for Fall 2017****SEPTEMBER 2017**

SUN	MON	TUES	WED	THUR	FRI	SAT
					1	2
3	4 <i>Labour day</i>	5 <i>Block week</i>	6 <i>Block week</i>	7 <i>Block week</i>	8 <i>Block week</i>	9
10	11 First Day of Classes	12	13	14	15	16
17	18	19 Tutorial 1	20	21	22 Last day to drop	23
24	25 Last day to add	26 Lab 1	27	28	29	30

**OCTOBER 2017**

SUN	MON	TUES	WED	THUR	FRI	SAT
1	2	3 Tutorial 2	4	5	6	7
8	9 <i>Thanksgiving</i>	10 Lab 2	11	12	13	14
15	16 Term test 1	17 Tutorial 3	18	19	20	21
22	23	24 Lab 3	25	26	27	28
29	30	31 Tutorial 4				

**NOVEMBER 2017**

SUN	MON	TUES	WED	THUR	FRI	SAT
			1	2	3	4
5	6 Term test 2	7	8	9	10 Reading day	11 Reading day <i>Remembrance Day</i>
12 Reading day	13 Reading day	14 Lab 4	15	16	17	18
19	20	21 Tutorial 5	22	23	24	25
26	27	28 Lab 5	29	30	Dec 1	

**DECEMBER 2017**

SUN	MON	TUES	WED	THUR	FRI	SAT
					1	2
3	4	5	6	7	8 Last day of classes	9
10	11 Exams begin	12	13	14	15	16
17	18	19	20	21 Exams end	22	23
24 <i>Xmas eve</i>	25 <i>Xmas Day</i> Xmas break	26 Xmas break	27 Xmas break	28 Xmas break	29 Xmas break	30