

UNIVERSITY OF CALGARY
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
Fall 2016

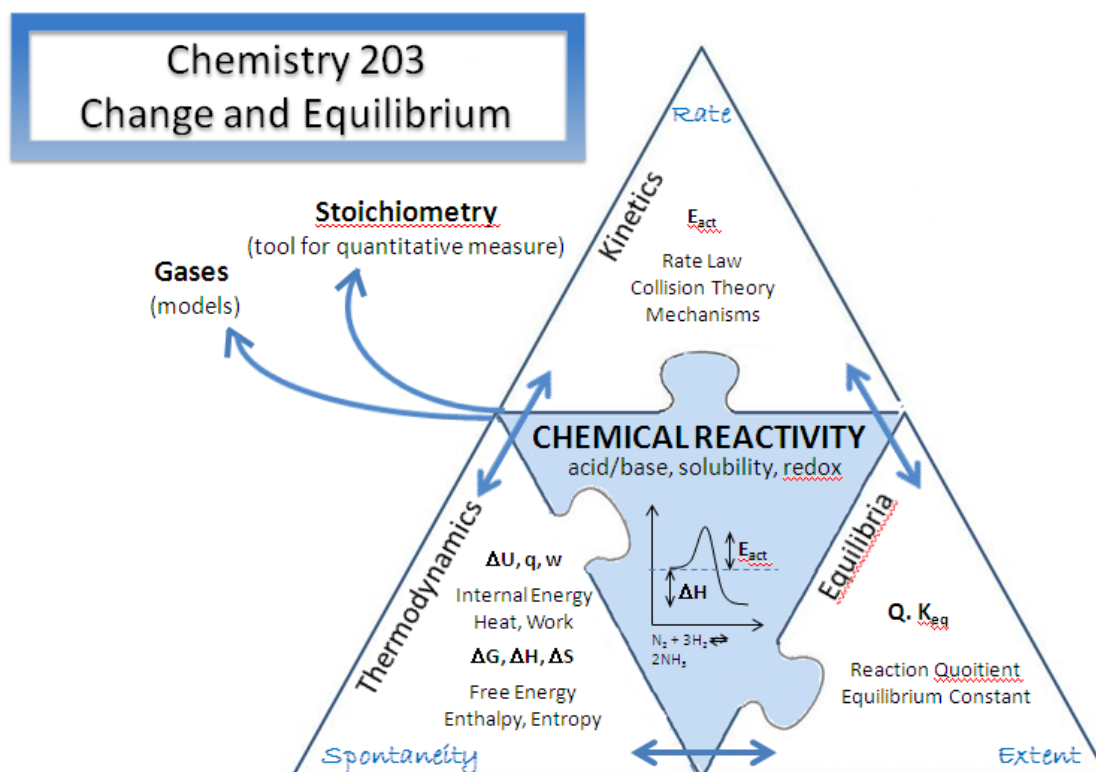
Course: Chemistry 203, General Chemistry: Change and Equilibrium

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	11:00-11:50	SB 103	Dr. Y. Carpenter	EEEL 237B	yyscarpe@ucalgary.ca	TBA
L02	MWF	12:00-12:50	SB 103	Dr. Y. Carpenter	EEEL 237B	yyscarpe@ucalgary.ca	
L03	TuTh	8:00-9:15	SB 103	Dr. P. Kusalik	SB 323	pkusalik@ucalgary.ca	

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

Course website: d2l.ucalgary.ca [CHEM 203 L01-L03 - (Winter 2016) - General Chemistry: Change and Equilibrium]
 Departmental Office: SA 229 | 403.220.5341 | chem.undergrad@ucalgary.ca

Rationale for the course: Chemical transformations are important across a broad set of disciplines. In Chemistry 203 you will gain understanding relating to foundational concepts (Equilibria, Thermodynamics, Kinetics, Stoichiometry and Gases) that are used to explain and examine chemical reactivity. Through the learning objectives for each understanding you will gain problem solving (critical thinking) and laboratory skills (teamwork and communication skills) that enable you to discuss chemical reactivity within YOUR discipline.



Course Learning Goals:

Enduring Understandings	Learning Objectives
<p>Gases and Stoichiometry</p> <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>
<p>Equilibrium</p> <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 K_{eq}.</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>
<p>Thermodynamics</p> <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>

Enduring Understandings	Learning Objectives
<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 $\Delta_r G$, $\Delta_r G^\circ$, Q and K.</p>
<p>Kinetics</p> <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>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>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> <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>
<p>Applying Chemical Equilibria: Acids & Bases</p> <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>Distinguish between K and pK and relate these values to acid/base strength and to hydronium ion concentrations $[H_3O^+]$ in solution.</p> <p>Quantitatively relate K_a, pK_a, K_b, pK_b, pH, $[H_3O^+]$ and $[OH^-]$.</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>

Enduring Understandings	Learning Objectives
Titration experiments are important for studying acids and bases.	Distinguish between the titration of strong acids/bases and the titration of weak acids/bases. Qualitatively and quantitatively describe how pH varies during a titration by identifying the major and minor species in solution at each stage. Use titration to determine the identity of an acid or base.
Applying Chemical Equilibria: Solubility The solubility of salts in aqueous solution is related to their extent of dissociation in water.	Qualitatively and quantitatively relate the solubility of salts to K_{sp} . Predict how the solubility of a salt will be affected by changing conditions.
Applying Equilibria and Thermodynamics: Electrochemistry An electrochemical cell provides a means to generate an electric potential from a redox reaction. The electrical potential generated by an electrochemical cell is related to the spontaneity and extent of the redox reaction.	Describe the components of an electrochemical cell. Generate or identify the electrochemical cell for a given redox reaction. Compare standard and non-standard cell potentials by qualitatively predicting how the cell voltage will change with concentration. Relate the cell voltage (E°_{cell}) and free energy ($\Delta_r G^{\circ}$) of reactions under standard conditions to the equilibrium constant (K) for a redox reaction.

Course Features:

Course material is cumulative so what will be learned at the start of the course will be continually applied throughout the term across all course components, including...

Lectures and in-class activities: We include demonstrations and peer discussion as key in-class activities. In-class *demonstrations* highlight the experiential nature of chemistry, engaging you in observation, prediction, and discussion. Top Hat will be used for in-class polling to prompt *peer discussion*; these questions not only help instructors pace course material and interact with students, but your participation helps you to build your understanding of the key ideas in-class.

Tutorials: Collaborating on tutorial activities with your peers, facilitated by TAs or instructors, gives you a chance to explore course topics in depth and communicate those ideas.

Laboratory experiments: Participation in laboratory experiments allow for hands-on experience in chemistry, along with key skills in data analysis and communication that will support you as a future scientist.

Term tests and final exam: In-class activities, tutorials and laboratory experiments as a whole will help you to prepare for Term Tests and Final Examinations. Examinations are a combination of multiple choice, short answer and written answer questions, which assess your knowledge and application of course concepts.

Responsibilities and Expectations:

What can you expect from your instructional team, including your instructor, coordinators, and TAs?

- **Respect:** For you, your ideas, your learning, and your time.
- **Resources:** To provide class activities, along with some suggested out-of-class resources to support you in learning the course material.
- **Feedback:** You will have several opportunities for formal feedback on your progress throughout the term (including ongoing pre-lab assignment and laboratory reports, pre-tutorial assignments and quizzes, as well as 2 term tests prior to your final exam). Prompt feedback on each activity should help inform you of your strengths and weaknesses so that you can improve your understanding and skills throughout the term. Informal feedback from TopHat polling questions and peer discussion can also help you identify challenging concepts.
- **Communication:** Do not be afraid to contact your instructor for help or clarification. Your instructor's office hours will be announced at the start of term, along with their contact information, if you need to make an appointment outside of these times.

In any e-mail, please **include the course and section number in the subject line**, and make sure to use full sentences so that instructors can give you the clearest response possible. Please anticipate that replies may take some time, due to instructors' other course responsibilities – if your instructor has a specific email policy, this will be detailed at the start of the course.

What do we expect from you?

- **Respect:** Be respectful of your instructors, TAs, and peers. This includes being present and on-task throughout class time to give your peers equal opportunity to learn and participate.
- **Reflection:** When you receive feedback, whether in-class or on assignments, use this as an opportunity to revisit ideas that may have been challenging as well as what strategies helped you succeed. Continually re-assess your performance, and if you are struggling please reach out to either your instructor or TAs as soon as possible.
- **Participation:** Come prepared for and be willing to participate in all course activities. Your learning and success depend on actively engaging with the material, both in- and out-of-class. Remember that this is more than just taking notes in lecture, but can include explaining your reasoning, making predictions, and doing practice calculation questions.
- **Organization:** Be as organized as possible – we expect you to have completed pre-lab and pre-tutorial assignments on time so that you can fully and safely participate in these activities. Submitting your lab reports on time not only avoids the grading penalties described in the lab manual, but also helps you get valuable timely feedback from your TAs.

We recognize that unforeseeable events happen. If this results in you having problems meeting any of your assignment submission dates, accommodations may be possible. Procedures for requesting these accommodations are detailed in the course outline.

Schedule for Fall 2016**SEPTEMBER 2016 CHEM 203**

SUN	MON	TUES	WED	THUR	FRI	SAT
	29	30	31	1	2	3
4	5 Labour day	6	7	8	9	10
11	12 First Day of Classes	13	14	15	16	17
18	19	20 Tutorial 1	21	22	23 Last day to drop	24
25	26 Last day to add	27 Lab 1	28	29	30	1

OCTOBER 2016

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

NOVEMBER 2016

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

DECEMBER 2016

SUN	MON	TUES	WED	THUR	FRI	SAT
		29 Lab 5	30	1	2	3
4	5	6	7	8	9 Fall term classes end	10
11	12 Exams begin	13	14	15	16	17
18	19	20	21	22 Exams end	23	24