

UNIVERSITY OF CALGARY
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
Spring 2016

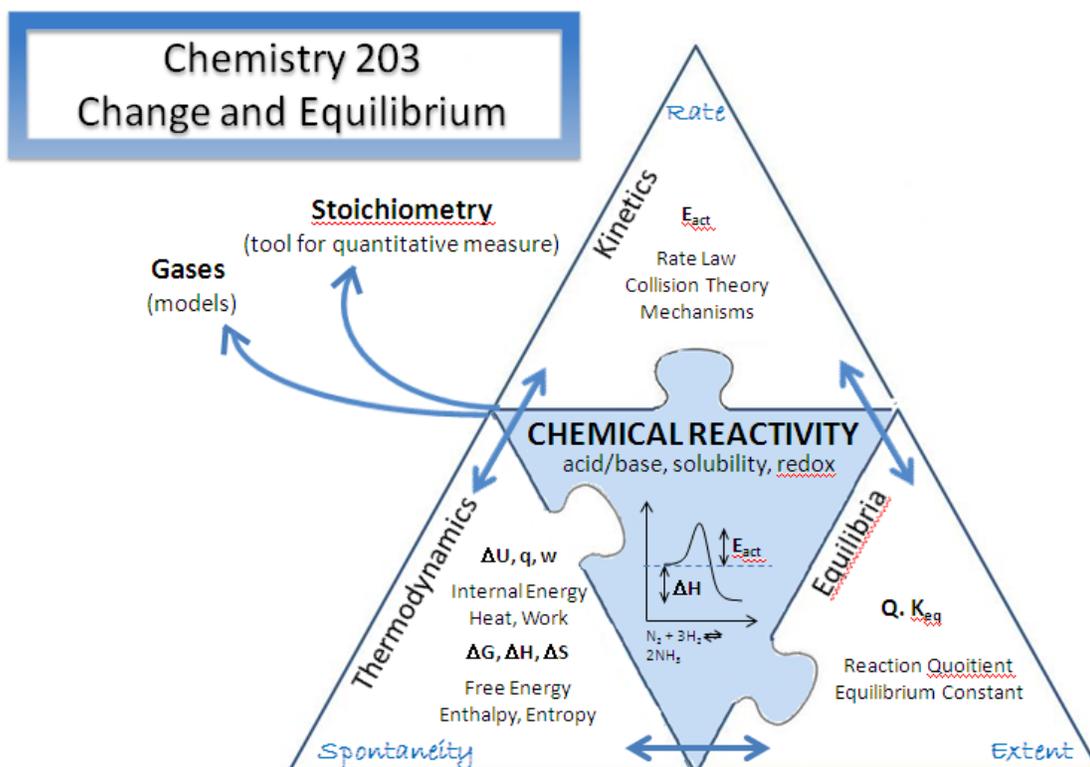
Course: Chemistry 203, General Chemistry: Change and Equilibrium

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	2:00-3:50	ST 141	Dr. B. Wheatley	SA 156	bmmwheat@ucalgary.ca	TBA

Course, Lab, and Tutorial coordinator: Dr. B. Wheatley (SA 156 | bmmwheat@ucalgary.ca)

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

Rationale for the course: Chemical reactivity is important across a broad set of disciplines. In Chemistry 203 you will gain understandings relating to foundational concepts that are used to explain and examine chemical reactivity (Equilibria, Thermodynamics, Kinetics, Stoichiometry and Gases). 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 models for understanding the microscopic nature of chemical reactivity.</p>	<p>Interpret, predict, and write formulas for chemical species.</p> <p>Identify, generate and balance chemical equations.</p> <p>Identify limiting and excess reactant(s) and use them to calculate theoretical and percent yields.</p> <p>Interconvert between concentrations, moles and masses of chemical species in solution.</p> <p>Describe the Kinetic Molecular theory of gases (KMT) and use it as a model to explain differences in energy and pressure in different samples of gases.</p> <p>Interconvert between partial pressures, mole fractions of gases with and total pressure of a gaseous system.</p> <p>Use the ideal gas law to do stoichiometric calculations involving gases.</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.</p>	<p>Qualitatively and quantitatively describe dynamic equilibria.</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>Quantitatively and qualitatively predict changes to a system at equilibrium resulting from adding a common ion or changing concentration, P, V or T.</p> <p>Use collision theory to explain your predictions about a the effects of different changes on a system at equilibrium.</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.</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>Calculate average and instantaneous rates of reaction using concentration vs. time data.</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>Use integrated rate laws to relate changes in concentration with time.</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>Explain the concept of a reaction mechanism and identify reasonable reaction mechanisms for a given reaction.</p> <p>Identify the rate-determining step, intermediates and catalysts present in a given reaction mechanism and use this information to determine the differential rate law for a reaction.</p> <p>Generate and identify the important kinetic components of a reaction coordinate diagram for a chemical reaction (<i>i.e.</i> transition state,</p>

Enduring Understandings	Learning Objectives
<p>Catalysts provide alternative mechanisms, thereby altering the energy changes that occur for a reaction.</p>	<p>intermediate, activation energy).</p> <p>Explain how reaction coordinate diagrams vary as the mechanism of a reaction varies</p> <p>Explain the effect of a catalyst on the activation energy of a reaction.</p>
<p>Thermodynamics</p> <p>Chemical reactivity involves energy changes.</p> <p>Reaction coordinate diagrams provide an understanding of the energy changes.</p> <p>The enthalpy, entropy and/or free energy changes of a reaction can be used to describe the spontaneity of a reaction.</p> <p>The spontaneity of chemical reactions can be varied.</p> <p>The spontaneity of a chemical reaction relates to the extent of the reaction.</p>	<p>Define the terms system, surrounding and universe as applied to a chemical reaction.</p> <p>Distinguish between standard and non-standard states.</p> <p>Relate changes in the internal energy of a reaction to the work done by/on the reaction and heat released/absorbed by the reaction.</p> <p>Use calorimetry to determine the amount of heat produced or absorbed by a chemical reaction.</p> <p>Calculate the pressure-volume work done by or on a system.</p> <p>Generate and use reaction coordinate diagrams to explain the energy changes that occur in a chemical reaction.</p> <p>Describe what happens at the molecular level when energy changes occur.</p> <p>Define and determine qualitatively and quantitatively the enthalpy and entropy changes for a reaction.</p> <p>Qualitatively and quantitatively relate enthalpy and entropy to the free energy or spontaneity of a chemical reaction.</p> <p>Qualitatively and quantitatively examine the temperature at which spontaneity changes.</p> <p>Interconvert between Δ_rG, Δ_rG°, Q and K.</p>
<p>Applying Chemical Equilibria: Acids & Bases</p> <p>The pH of an aqueous acid or base solution is determined by the extent of their reaction with water.</p> <p>Chemists can alter the extent of 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>Acids and Bases are studied using titration experiments.</p>	<p>Distinguish between K and pK and relate it to the hydronium ion concentration $[H_3O^+]$ in solution.</p> <p>Quantitatively relate K, pK, pH, $[H_3O^+]$ and $[OH^-]$.</p> <p>Calculate the theoretical pH value for an acid or a base in aqueous solution.</p> <p>Qualitatively and quantitatively determine the effect of adding a common ion to an acidic or basic 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>Determine the acid or base buffer capacity of a solution.</p> <p>Distinguish between the titration of strong acids/bases and the titration of weak acids/bases.</p>

Enduring Understandings	Learning Objectives
	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. Select an appropriate indicator for a given acid/base titration.
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 (concentration, temperature, addition of acids, bases, complexing reagents etc.....).
Applying Equilibria and Thermodynamics: Electrochemistry The cell potential generated by a redox reaction relates to the spontaneity and extent of that 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 and predict or calculate 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 Spring 2016**May 2016**

SUN	MON	TUES	WED	THUR	FRI	SAT
1	2	3	4	5	6	7
8	9 Lectures Begin	10 Tut 1 and Lab 1	11	12	13 Last day to drop without record	14
15	16	17 Tut 2 and Lab 2	18	19	20	21
22	23 Victoria Day	24	25	26 Reading Break	27 Reading Break	28 Reading Break
29 Reading Break	30 Reading Break	31 Reading Break				

June 2016

SUN	MON	TUES	WED	THUR	FRI	SAT
			1 Reading Break	2 Reading Break	3 Reading Break	4 Reading Break
5 Reading Break	6	7 Tut 3 and Lab 3	8	9	10	11
12	13	14 Tut 4 and Lab 4	15	16	17	18
19	20	21 Tut 5 and Lab 5	22	23	24	25
26	27	28	29	30 Last Day of Classes		

July 2016

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