UNIVERSITY OF CALGARY
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
Fall 2015

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. A. Musgrove-Richer	EEEL 237C	amanda.musgroveriche @ucalgary.ca	

Course and Tutorial coordinator: Dr. Yuen-ying Carpenter (EEEL 237B | yyscarpe@ucalgary.ca)
Lab coordinator: Dr. Amanda Musgrove-Richer (EEEL 237C | amanda.musgroveriche@ucalgary.ca)

Course website: d2l.ucalgary.ca [CHEM 203 L01-L03 - (Fall 2015) - General Chemistry: Change and Equilibrium]
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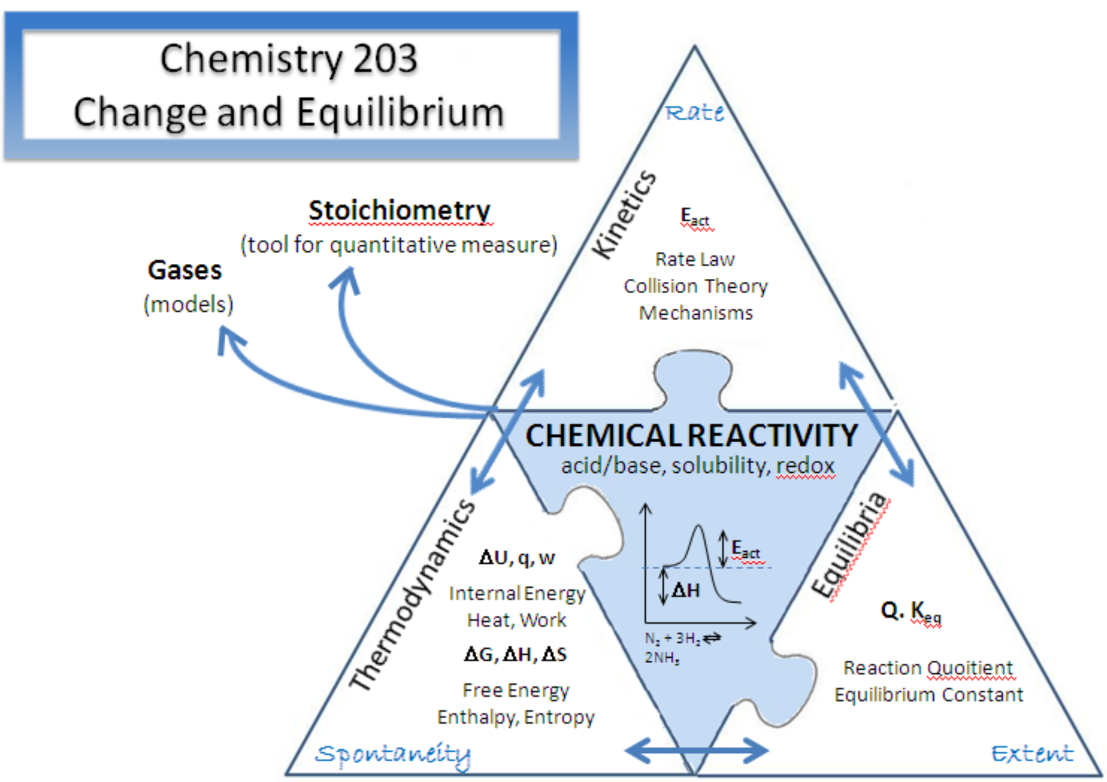
Rationale for the course: Chemical reactivity is important across a broad set of disciplines. In Chemistry 203 you will gain understandings relating to foundational concepts that are used to explain and examine chemical reactivity (Equilibria, Thermodynamics, Kinetics, Stoichiometry and Gases). Through 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.



All pictures, unless otherwise specified, were taken with permission from Kotz, Treichel & Townsend, "Chemistry and Chemical Reactivity", 8th edition, Brooks/Cole, 2012.

Course Learning Goals:

Enduring Understandings	Learning Objectives
Gases and Stoichiometry	
To determine what is happening quantitatively in chemical reactions one must use the principles of stoichiometry.	Interpret, predict, and write formulas for chemical species. Identify, generate and balance chemical equations. Identify limiting and excess reactant(s) and use them to calculate theoretical and percent yields. Interconvert between concentrations, moles and masses of chemical species in solution.
Gases are good models for understanding the microscopic nature of chemical reactivity.	Describe the Kinetic Molecular theory of gases. Interconvert between partial pressures, mole fractions of gases with and total pressure of a gaseous system. Use the ideal gas law to do stoichiometric calculations involving gases. Describe the limitations of the ideal gas law
Equilibrium	
Most reactions attain a state of dynamic equilibrium.	Qualitatively and quantitatively describe dynamic equilibria.
The reaction quotient is used to determine the progress or extent of a reaction mixture.	Write K/Q expressions for an equilibrium reaction. Use K and Q values to predict the direction of a reaction for a given set of reaction conditions (concentrations, P's, T etc.).
The extent of a reaction can be altered.	Quantitatively and qualitatively predict changes to a system at equilibrium that result from addition of a common ion or from changes in concentration, P, V or T.
Kinetics	
The rate law is used to quantitatively examine the rate of a reaction.	Calculate average and instantaneous rates of reaction using concentration *vs.* time data. Determine the differential and/or integrated rate laws for a given reaction using experimental data. Determine the half-life ($t_{1/2}$) of a given reaction from the rate law.
The rate of a reaction can be altered.	Predict the change in the rate of reaction that results from changing reactant concentrations or temperature, or from the addition of a catalyst.
Rates can be explained at a molecular-level using collision theory.	Use collision theory to qualitatively explain differing reaction rates. Use the Arrhenius equation to quantify the relationships between the activation energy, temperature and rate constant.
Reactions can occur via a series of steps or a mechanism.	Explain the concept of a reaction mechanism and identify reasonable reaction mechanisms for a given reaction. 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.

Enduring Understandings	Learning Objectives
Reaction coordinate diagrams provide a representation of the energy changes that influence rate.	Generate and identify the important kinetic components of a reaction coordinate diagram for a chemical reaction (*i.e.* transition state, intermediate, activation energy).
	Explain how reaction coordinate diagrams vary as the mechanism of a reaction varies
Catalysts provide alternative mechanisms, thereby altering the energy changes that occur for a reaction.	Explain the effect of a catalyst on the activation energy of a reaction.
Thermodynamics	
Chemical reactivity involves energy changes.	Define the terms system, surrounding and universe as applied to a chemical reaction.
	Relate changes in the internal energy of a reaction to the work done by/on the reaction and heat released/absorbed by the reaction.
	Use calorimetry to determine the amount of heat produced or absorbed by a chemical reaction.
	Calculate the pressure-volume work done by or on a system.
Reaction coordinate diagrams provide an understanding of the energy changes.	Generate and use reaction coordinate diagrams to explain the energy changes that occur in a chemical reaction.
	Describe what happens at the molecular level when energy changes occur.
The enthalpy, entropy and/or free energy changes of a reaction can be used to describe the spontaneity of a reaction.	Define and determine qualitatively and quantitatively the enthalpy and entropy changes for a reaction.
	Distinguish between standard and non-standard states.
	Qualitatively and quantitatively relate enthalpy and entropy to the free energy or spontaneity of a chemical reaction.
The spontaneity of chemical reactions can be varied.	Qualitatively and quantitatively examine the T at which spontaneity changes.
The spontaneity of a chemical reaction relates to the extent of the reaction.	Interconvert between $\Delta_r G$, $\Delta_r G^0$, *Q and K.*
Chemical Reactivity	
The pH of an aqueous acid or base solution is determined by the extent of their reaction with water.	Distinguish between K and pK and relate it to the hydronium ion concentration $[H_3O^+]$ in solution.
	Quantitatively relate K, pK, pH, $[H_3O^+]$ and $[OH^-]$.
	Calculate the theoretical pH value for an acid or a base in aqueous solution.
The varying strength of acids and bases can be explained by examining structure.	Qualitatively relate differences in K to the variation in structure of an acid or base.
Chemists can alter the extent of reaction with water.	Qualitatively and quantitatively determine the effect of adding a common ion to an acidic or basic solution.
Weak acids and bases are used to prepare buffer solutions that are used to resist changes in pH.	Describe how a buffer functions and outline how to prepare a buffer with a given pH.

Enduring Understandings	Learning Objectives
	Calculate the pH of a buffer solution before and after the addition of strong acids or bases.
Acids and Bases are studied using titration experiments.	Qualitatively and quantitatively describe how pH varies throughout a titration. Use titration to determine the identity of an acid or base. Select an appropriate indicator for a given acid/base titration.
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}. Interpret how the solubility of a salt can be affected by changing reaction conditions (concentrations, temperature, addition of acids, bases, complexing reagents etc....).
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. Qualitatively and quantitatively differentiate between standard and non-standard cell potentials. Qualitatively and quantitatively relate the cell voltage (E^{o}_{cell}), free energy ($\Delta_r G^0$) and equilibrium constant (K) of 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.

Textbook information

Chemistry and Chemical Reactivity, *Ninth Edition* by J.C. Kotz, P.M. Treichel and J.R. Townsend, Brooks/Cole, CENGAGE Learning, 2015.

This list of suggested textbook exercises is by no means comprehensive. Use this guide as a launching point for learning about how to tackle ideas and problems about these topics.

Topic	Textbook sections	Suggested exercises from the textbook
Stoichiometry (*Review*)	Review Chapters 1-4 *These chapters contain background information from high school chemistry*	2.157, 2.161, 3.35, 3.45, 3.69, 3.73, 4.3, 4.6, 4.10, 4.20, 4.39, 4.47, 4.59, 4.61, 4.93, 4.111
Gases	Chapter 10 – all sections *Focus on 10.5 & 10.6*	10.33, 10.37, 10.42, 10.67, 10.69, 10.91, 10.107
Kinetics	Chapter 14 – all sections	14.3, 14.5, 14.9, 14.11, 14.15, 14.23, 14.25, 14.31, 14.39, 14.41, 14.46, 14.55, 14.81, 15.89, 14.91, 14.93
Chemical Equilibria	Chapter 15 – all sections. Background material 15.1, 15.2 & 15.6	15.1, 15.5, 15.9, 15.11, 15.13, 15.15, 15.21, 15.23, 15.27, 15.29, 15.45, 15.59, 15.67, 15.69, 15.72
Thermodynamics	Chapter 5 – all sections *Focus on 5.4, 5.5 & 5.7* Chapter 18 – all sections.	5.1, 5.9, 5.11, 5.25, 5.30, 5.33, 5.37, 5.51, 5.53, 5.59, 5.65, 5.69, 5.73, 5.81(a,b,d), 5.119 18.3, 18.7, 18.13, 18.15, 18.19, 18.25, 18.27, 18.35, 18.55, 18.59, 18.69, 18.79, 18.87
Chemical Reactivity	Acids and Bases Chapter 16 – all sections Buffers & Solubility of Salts Chapter 17 – all sections Redox Reactions Chapter 19 – all sections	16.3, 16.5, 16.11, 16.13, 16.15, 16.21, 16.27, 16.29, 16.33, 16.39, 16.43,16.51, 16.55, 16.61, 16.63, 16.65, 16.73, 16.97, 16.98, 16.107 17.3, 17.5, 17.7, 17.15, 17.19, 17.23, 17.27, 17.29, 17.35, 17.41, 17.41, 17.49, 17.55, 17.57, 17.63, 17.67, 17.75, 17.79, 17.91, 17.105, 17.109, 17.116 19.3, 19.5, 19.7, 19.9, 19.19, 19.21, 19.31, 19.33, 19.35, 19.55, 19.59, 19.67, 19.99(a-h)

Schedule for Fall 2015

SEPTEMBER 2015

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

OCTOBER 2015

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

NOVEMBER 2015

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

DECEMBER 2015

SUN	MON	TUES	WED	THUR	FRI	SAT
		1	2	3	4	5
6	7	Lectures End 8	9	10 Fall term final exams	11	12
13	14	15	16	17	18	19
20	21 Fall term final exams end	22	23	24 Xmas Eve	25 Xmas break	26 Xmas break
27 Xmas break	28 Xmas break	29 Xmas break	30 Xmas break	31		