UNIVERSITY OF CALGARY

UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
SPRING 2019

1. Course: CHEMISTRY 203, General Chemistry: Change & Equilibrium

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	14:00-15:50	EEEL 161	Dr. Bronwen Wheatley	SA 158	Li22@ucalgary.ca	by appointment

See Dr. Li for lecture and lab coordination.

Tutorials begin Thursday, May 16th; labs begin Tuesday, May 14nd, 2019.

D2L site: CHEM 203 L01 - (Spring 2019) - General Chemistry: Change and Equilibriumm

Department of Chemistry: Room SA 229, Tel: (403) 220-5341, e-mail: chem.info@ucalgary.ca

Students must use their U of C account for all course correspondence.

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: Chemistry by Flowers, Theopold, Langley, Robinson, et al. and published by Open Stax . Note: Our recommended text is an open-educational resource, freely available online through the Open Stax website (https://openstax.org/details/books/chemistry?Book%20details). You are welcome to (i) refer to the text online, (ii) download the PDF to your own device, or (iii) purchase a print copy through the bookstore.

4. Topics Covered and Suggested Readings:

Course Contents	**Chapter in Textbook** *(not all sections will be covered)*
Gases and 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. 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. 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.	Chapters 1-4, 9
Equilibrium Qualitatively and quantitatively describe dynamic equilibria. 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, T etc.). Quantitatively and qualitatively predict changes to a system at equilibrium resulting from adding a common ion or changing n, V, or T. Use collision theory to explain your predictions about the effects of different changes on a system at equilibrium.	Chapter 13

Kinetics Chapter 12

Calculate average and instantaneous rates of reaction using concentration vs. time data.
Use graphs of concentration vs. time to compare rates and rate laws for different reactions.
Determine the differential and/or integrated rate laws for a given reaction using experimental data.
Use integrated rate laws to relate changes in concentration with time.
Predict the change in the rate of reaction that results from changing reactant concentrations or temperature, or from the addition of a catalyst.
Use collision theory to qualitatively explain differing reaction rates.
Chapter 12
Use the Arrhenius equation to quantify the relationships between the activation energy, temperature and rate constant.
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.
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 Explain the effect of a catalyst on the activation energy of a reaction.

Thermodynamics Chapters 5, 16

Define the terms system, surrounding and universe as applied to a chemical reaction.
Distinguish between standard and non-standard states.
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.
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.
Define and determine qualitatively and quantitatively the enthalpy and entropy Changes for a reaction.
Qualitatively and quantitatively relate enthalpy and entropy to the free energy or spontaneity of a chemical reaction.
Qualitatively and quantitatively examine the temperature at which spontaneity changes.
Interconvert between ΔG, $\Delta G°$, Q and K.

Acids and Bases Chapters 14

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.
Qualitatively and quantitatively determine the effect of adding a common ion to an acidic or basic solution.
Describe how a buffer functions and outline how to prepare a buffer with a given pH.
Calculate the pH of a buffer solution before and after the addition of strong acids or bases.
Determine the acid or base buffer capacity of a solution.
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.
Select an appropriate indicator for a given acid/base titration.

Solubility Chapter 15.1

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...).

Electrochemistry | Selected parts of Chapter 17

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 ($\Delta G°$) of reactions under standard conditions to the equilibrium constant (K) for a redox reaction.

5. **Laboratory Experiments:** (5 weeks, 3 hours/ week)

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

   Experiment 2. Determining the equilibrium constant for the formation of ferric thiocyanate, Fe(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. **Tutorial Activities:** (5 weeks, 1.5 hours/ week)

   1. Peer-Assisted Reflection; gases and stoichiometry
   2. Tutorial exercise and quiz; energy
   3. Peer-Assisted Reflection; equilibrium
   4. Tutorial exercise and quiz; kinetics
   5. Peer-Assisted Reflection; acid-base titrations

Department Approval____Date__________________________