UNIVERSITY OF CALGARY
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
SPRING 2016

1. Course: Chemistry 201, General Chemistry: Structure and Bonding

LEC	DAYS	TIME	ROOM	INSTRUCTORS	OFFICE	EMAIL
L01	MWF	12:00-1:50	SA 106	Kyle Hall	SA 156	hallkw@ucalgary.ca
			SA 106	Vivian Mozol	SA 144E	vjmozol@ucalgary.ca

Course and Tutorial and Laboratory Coordinator: Mr. Kyle Hall (SA 156, hallkw@ucalgary.ca)
Course website d2l.ucalgary.ca: CHEM 201 L01 (Spring 2016) - General Chemistry: Structure & Bonding
Departmental Office: SA 229, 220-5341, chem.undergrad@ucalgary.ca

Textbook references in this syllabus refer to:
J.C. Kotz, P.M. Treichel, J.R. Townsend, D.A. Treichel, Chemistry and Chemical Reactivity, 9th Edition. Brooks/Cole CENGAGE Learning.

Material from Chem 20 and/or Chem 30 that is expected background knowledge:

Stoichiometry
Chapters 1-4.

Atoms
Chapter 6.1-6.2.

Chapter coverage in Chemistry 201:

Atoms
Chapter 6 – The Structure of Atoms – all sections
Chapter 7 – The Structure of Atoms and Periodic Trends – all sections

Chemical Species
Chapter 8 – Bonding and Molecular Structure – all sections
Chapter 9 – Bonding and Molecular Structure: Orbital Hybridization and Molecular Orbitals – selected sections

Collections of Chemical Species
Chapter 11 – Intermolecular Forces and Liquids – all of: 11.1 through 11.5
11.6 selected topics only.

Applying Structure and Bonding Concepts - Organic Chemistry
Chapter 23 – Carbon: Not Just Another Element – parts of: 23.1-23.4

Department Approval: Approved by Department Head Date: April 28, 2016

Rationale for the course: Chemical reactivity and properties are important across a broad range of scientific domains. Evaluating chemical reactivity and properties requires understanding of chemical structure and bonding. In Chemistry 201, you will gain understanding of chemical structure and bonding as they relate to the behaviour of atoms, chemical species, and collections of chemical species. Below and on the following pages, the aims of this course and their associated learning objectives are detailed. Course aims and learning objectives will be realized through the lectures, laboratories, tutorials, assignments or some combination thereof. The communication and problem solving learning objectives indicate means through which students will gain and demonstrate content-based course aims and learning objectives. Content-based course aims and learning objectives indicate the chemical knowledge and skills that will be developed in Chemistry 201.

Course Aims and Learning Objectives: Communication and Problem Solving

Course Aims: **What you will understand by the end of the course…**	**Learning Objectives:** **What you will be able to do by the end of the course…**
Problem solving and communication are the means through which chemical knowledge is developed and shared.	-Extract key concepts from scientific discussions and texts -Summarize scientific concepts and share these summaries with others -Rationalize quantitatively and qualitatively using chemical information -Construct and deconstruct a scientific argument according to data, experiment results, or supplementary text. -Use stylistic writing conventions appropriate for chemistry

Course Aims and Learning Objectives: Content

ATOMS

Course Aims: **What you will understand by the end of the course…**	**Learning Objectives:** **What you will be able to do by the end of the course…**
Atomic Spectra can be used to elucidate the electronic structure of atoms.	-Demonstrate the relationship between frequency, wavelength and energy of light. -Explain qualitatively how an atomic spectrum is obtained experimentally. -Describe how the energy of electrons are quantized. -Discriminate between the ground and excited states of an electron in an atom. -Explain how energy can be used to excite or remove electrons from atoms. -Relate the energy, wavelength or frequency of any photon in an atomic spectrum to the difference between ground and excited states.
The energy and spatial distribution of electrons in atoms is explained using Quantum Theory.	-Describe the wave character of electrons. -Explain how the wave character of an electron gives rise to orbitals -Relate orbitals to the quantized energies of electrons in atoms -Associate quantum numbers with orbitals. -Draw the boundary, electron density and radial probability diagrams for the orbitals in the first three electron shells of an atom. -Define the concept of a node & identify node(s) within an orbital diagram. -Draw the energy levels for the first four shells of an atom. -Identify a possible set of quantum numbers for any electron.
Every element has a unique arrangement of electrons.	-Determine the ground state electron configurations for the first 36 elements using Aufbau, Pauli and Hund's principles. -Generate electron configurations in *spdf* notation, using energy diagrams or orbital box diagrams, and rationalize when to use one type versus another. -Identify and differentiate between core electrons, valence electrons and isoelectronic species. -Identify and differentiate between ground and excited states for atoms. -Recognize and explain the reason for exceptions to ground state configurations. -Determine the electron configurations for stable ions of the elements.
The electron configurations of atoms can be used to help explain the physical properties of the elements and their compounds.	-Identify paramagnetic and diamagnetic species. -Rationalize physical properties using the distance the valence electrons are from the nucleus (n) and the pull of the nucleus on these electrons (Z*). -Explain changes in size, ionization energy and electron affinity for an atom and its ions. -Order a given series of elements or ions by size, ionization energy and/or electron affinity then justify the answer. -Recognize the relationship between electron affinity and electron attachment enthalpy.

CHEMICAL SPECIES

What you will understand by the end of the course…	What you will be able to do by the end of the course…
Bonding involves the rearrangement of valence electrons.	-Define electronegativity. -Predict and rationalize the type of bonding that occurs between atoms by using electronegativity differences. -Describe covalent and ionic bonding.
Lewis diagrams show the connectivity between atoms as a result of the rearrangement of valence electrons.	-Generate valid Lewis diagrams that show all non-zero formal charges. -Generate valid Lewis diagrams for a chemical formula or condensed formula and vice versa. -Analyze Lewis diagrams to determine their validity. -Recognize when the octet rule can be violated. -Determine bond orders within a chemical species. -Identify bonds of significant polarity in a chemical species.
Some chemical species may display resonance.	-Generate and identify valid resonance structures. -Distinguish equivalent from non-equivalent resonance structures. -Recognize when a chemical species is said to display resonance. -Use curly arrows to interconvert resonance structures. -Generate and identify a valid resonance hybrid, which includes formal charges and bond orders, for a set of resonance structures.
Regions of significant polarity can be used to identify functional groups and is important in naming a chemical species.	-Identify the following functional groups: alkanes, alkenes, alkynes, alcohols, ethers, aldehyde, ketone, carboxylic acids, esters, amines, amides and acid chlorides. -Generate a name given the structure for an organic compound that possesses a single functional group and vice versa.
Valence Shell Electron Pair Repulsion (VSEPR) structures show the spatial arrangement of atoms within chemical species.	-Build VSEPR diagrams from valid Lewis diagrams and vice versa. -Build Line drawings from valid VSEPR diagrams and vice versa. -Assign electron-pair geometry and molecular shapes to atoms bonded to two, three, four, five or six other atoms. -Assign approximate bond angles. -Recognize variations in orientation of VSEPR diagrams for the same geometries/shapes. -For species that display resonance describe why resonance hybrids are used to identify and draw valid VSEPR diagrams.
The same number and type of atoms can connect and orient themselves in space in several different ways. This results in isomerism, which is important in naming a chemical species.	-Recognize constitutional, conformational, geometric and optical isomerism. -Generate constitutional, conformational, geometric and optical isomers for a given set of atoms. -Identify chiral centers. -Generate a name given the structure of either a constitutional or geometric isomer and vice versa.
The spatial arrangement of atoms determines the charge distribution of a chemical species.	-Distinguish between bond polarities, and molecular polarity. -Determine the overall molecular polarity of a chemical species. -Identify polar and non-polar molecules.
Valence Bond Theory (VBT) and Molecular Orbital Theory (MOT) are used to explain the spatial arrangement of bonds.	-Contrast VBT and MOT. -Draw the energy diagrams for unhybridized and hybridized atoms. -Draw and show orientation of the sigma and pi overlaps for a chemical species. -Name hybridized orbitals and orbital overlaps according to VBT. -Draw energy diagrams for atomic orbitals and show how they combine to give molecular orbitals. -Build, draw and name the molecular orbitals for bonding and antibonding interactions in MOT.

COLLECTIONS OF CHEMICAL SPECIES

What you will understand by the end of the course…	**What you will be able to do by the end of the course…**
Chemical Substances are collections of chemical species that interact with each other.	-Explain the nature of the interactions between chemical species. -Identify and differentiate the types of interactions exist between chemical species (pure samples and mixtures). -Explain how the strength of intermolecular interactions differ for a solid, liquid and gas.
The physical properties and chemical reactivity of substances depend on the interactions between chemical species.	-Understand the difference between a physical and chemical change. -Use intermolecular interactions to explain or predict relative boiling points, viscosities, surface tension, wetting and diffusion rates for two different pure substances. -Use interactions between chemical species to explain or predict solubility or miscibility. -Use intermolecular interactions to rationalize why molecules react -Use structures and curved arrows to explain bond breaking and bond making.

Format and Procedures:

The lectures will form the backbone of the course, but emphasis will be placed on learning both in the lectures and outside of the lectures.

Assignments, experiments, in-class activities, and tutorials are integral parts of this course, and have a synergistic relationship with the lectures. Knowledge and skills gained through these activities are examinable material for both the term test and final. The aforementioned activities are meant to augment the lectures both by 1) enabling students to practice knowledge and skills gained through the lecture, and 2) gaining new knowledge and skills not explored in the lectures.

As the term progresses, concepts and skills introduced earlier in the course will form the foundation of more advanced concepts and skills later in the course. That is to say, the course material builds on itself. **Therefore, it is crucial that students seek help as soon they encounter difficulties.**

TopHat will be used to: 1) help students recognize gaps in their knowledge and skills, and 2) help the instructors adjust their delivery of material to aid students as students address these gaps. All TopHat questions contribute to the 2% grade mentioned in the course outline. There will be both graded and participatory TopHat questions. For graded questions, the correctness of a student's response will dictate their mark on the TopHat question. For participatory questions, a student will receive a completion mark for responding.

Examinations are given to assess your strengths and weaknesses regarding both the content-based and communication/problem solving course learning objectives.

Responsibilities and Expectations:

What is expected from you:

- Respect for your fellow students, TA’s and instructors
- Completion of assigned non-graded practice problems as a way to monitor your progress in the course
- Self monitoring of your progress in the course, and your reaching out to both TA’s and instructors when you encounter difficulties
- A willingness to participate in all in-class activities
- On-time completion of all material (e.g. labs, tutorials, assignments, etc.)
- Usage of electronics in lectures, labs and tutorials must be solely for purposes related to the course (e.g. for TopHat or for taking notes). If your electronic usage becomes a distraction to other students in the course, you may be asked to leave the lecture and/or electronics may be fully banned from subsequent lectures.

What you can expect from your instructors:

- Respect for you and your fellow students
- A willingness to help you as much as possible (e.g. by answering your questions in the lecture, via email, or through meetings)
- Assistance with the development of your self-monitoring skills
- Formal feedback on your progress throughout the term (e.g. the term test, labs, tutorials, etc.)
- The timely return of graded coursework

CHEM 201 – Spring 2016 Course Calendar

Below are the dates of the experiments, tutorials, term test and final as well as their contributions to students' overall percentage grades. For experiments, tutorials and the final, you will need to consult your own schedule in PeopleSoft for rooms and exact dates.

TopHat/In-class quizzes, in-class activities and assignments will occur throughout the term, and constitute **12%** of students' overall percentage grades as is detailed in the course outline.

From May 26th to June 5th, a congress is being held at the university, so there will be no classes. However, the first assignment will be distributed to students on May 25th and will be due June 6th.

MAY 2016

SUN	MON	TUES	WED	THUR	FRI	SAT
1	2	3	4	5	6	7
8	9 **Lectures Start**	10	11	12	13 **Add/Drop**	14
15	16 **Tutorial 1** 2%	17	18 **Expt 1** (worksheet) 5%	19	20	21
22	23 VICTORIA DAY	24	25	26	27	28
29	30	31	28	29	30	31

JUNE 2014

SUN	MON	TUES	WED	THUR	FRI	SAT
			1	2	3	4
5	6 **Tutorial 2** 2%	7	8 **Expt 2** (full report) 5%	9	10 **Term Test** 18%	11
12	13 **Tutorial 3** 2%	14	15 **Expt 3** (full report) 5%	16	17	18
19	20 **Tutorial 4** 2%	21	22 **Expt 4** (worksheet) 5%	23	24	25
26	27 **Tutorial 5** 2%	28	29 **Lectures End** **Expt 5** (worksheet) 5%	30		

JULY 2016

SUN	MON	TUES	WED	THUR	FRI	SAT
					1	2 **Final** 35% Exact date and location to be announced
3	4	5	6	7	8	9