UNIVERSITY OF CALGARY

UNIVERSITY OF CALGARY
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
WINTER 2016

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL
L01	MWF	11:00-11:50	SB 103	Dr. E. Sullivan	SA 144D	ersulliv@ucalgary.ca
L02	MWF	12:00-12:50	SB 103	Dr. V. Mozol	SA 144E	vjmozol@ucalgary.ca
L03	TR	8:00-9:15	SB 103	Dr. E. Sullivan	SA 144D	ersulliv@ucalgary.ca

Course and Tutorial Coordinator: Dr. Erin Sullivan (SA 144D, ersulliv@ucalgary.ca)
Laboratory Coordinator: Dr. Amanda Musgrove-Richer (EEEL 237C, amanda.musgroveriche@ucalgary.ca)
Course website d2l.ucalgary.ca: CHEM 201 L01-L03 (Winter 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:

<u>Stoichiometry</u>
Chapters 1-4.

<u>Atoms</u>
Chapter 6.1-6.2.

Chapter coverage in Chemistry 201:

<u>Atoms</u>
Chapter 6 – The Structure of Atoms – all sections
Chapter 7 – The Structure of Atoms and Periodic Trends – all sections

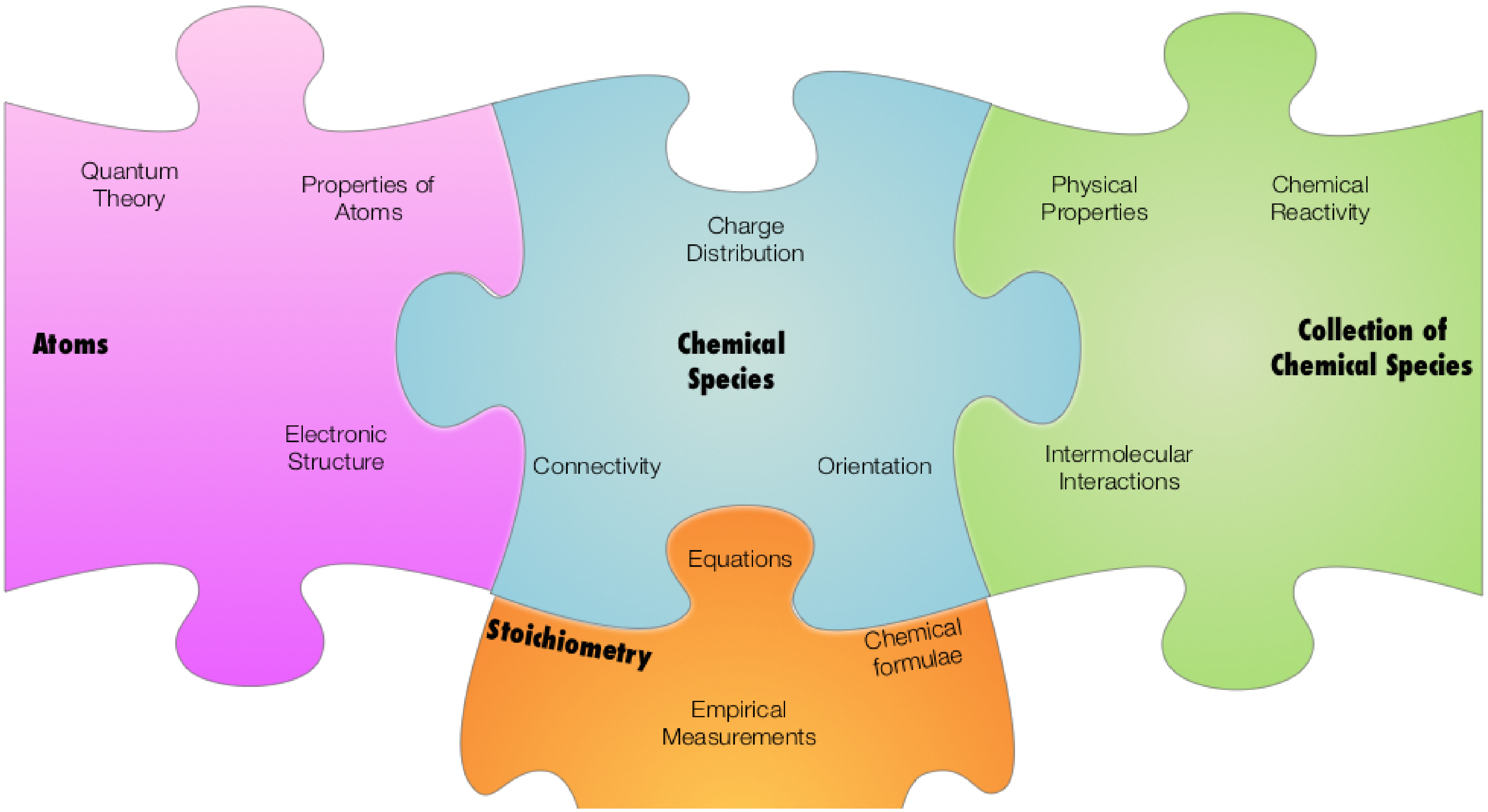
<u>Chemical Species</u>
Chapter 8 – Bonding and Molecular Structure – all sections
Chapter 9 – Bonding and Molecular Structure: Orbital Hybridization and Molecular Orbitals – selected sections

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

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

Department Approval: Approved by Department Head Date: December 11, 2015

Rationale for the course: Chemical reactivity is important across a broad set of disciplines. Evaluating chemical reactivity requires a sound understanding of chemical structure and bonding. In Chemistry 201 you will gain understandings relating to foundational concepts in structure and bonding (Atoms, Chemical Species and Collections of Chemical Species). The course map shown below is a basic skeleton and will become more detailed as the semester progresses. 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 the structure and bonding of chemical substances within YOUR discipline................how cool is that!



Course aims and objectives:

STOICHIOMETRY

Enduring Understandings **You are expected to understand…**	**Learning Objectives** **You are expected to be able to…**
Chemists describe chemical species using chemical formulae.	-Determine the chemical formula of a chemical species from its Lewis structure. -Associate the chemical symbol to the name of the elements in the first 5 periods of the periodic table (H to Xe). -Determine the molar mass of a chemical species.
Chemical formulas and equations are used to solve quantitative problems.	-Balance a chemical reaction given the reactant(s) and product(s) (for example: acid/base or redox reactions). -Identify the limiting and excess reagents given experimental data. -Determine the theoretical and percent yield of a chemical reaction.
Empirical measurements determine the type of calculations used to solve quantitative problems.	-Calculate and convert between the following quantities: number of moles, mass, concentration (mol/L, % w/w), volume, density. -Convert between magnitude of measurement units commonly used in the metric system: kilo, deci, milli, micro, nano and pico. -Perform dilution calculations and determine the consequences of using dilute vs. concentrated solutions.

Course aims and objectives:

ATOMS

What you will understand by the end of the course…	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. The electronic structure of atoms is key to how they come together to form chemical species.	-Demonstrate the relationship between frequency, wavelength and energy of light. -Explain qualitatively how an atomic spectrum is obtained experimentally. -Describe how the energy of e-s are quantized. -Discriminate between the ground and an excited state for an electron in an atom. -Explain how energy can be used to excite or remove e-s 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 e-s. -Explain how the wave character of an e- can be used to generate an orbital or the area in space within which an electron may be found. -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 e-.
Every element has a unique arrangement of electrons.	-Determine the ground state e- configurations for the first 36 elements using Aufbau, Pauli and Hund's principles. -Generate e- 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 e-s, valence e-s 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 e- 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 e-s are from the nucleus (n) and the pull of the nucleus on these e-s (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.

Course aims and objectives:

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 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.

Course aims and objectives:

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 forces between chemical species. -Identify and differentiate the types of forces 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 at the site of functional groups. -Use structures and curved arrows to explain bond breaking and bond making.

Format and Procedures:

All classes are cumulative so what will be learned at the start of the course will be continually applied throughout the term.

In-class demonstrations will highlight the experiential nature of the discipline and allow for group discussion but participation in laboratory experiments allow for hands-on experience.

The use of TopHat for in-class polling is designed to help inform you about your strengths and weaknesses in knowledge or its application and inform lecturers how to pace coverage of course material.

Tutorials are opportunities to work in groups and learn how to take good notes.

In-class activities, tutorials and 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. Examinations are given to assess your strengths and weaknesses regarding the knowledge and application of structure/bonding concepts.

Responsibilities and Expectations:

<u>What you can expect from the course and your instructors:</u>

- All instructors will try to help you as much as possible. Do not be afraid to contact them. Their contact information is available on the course website.
- You will have several opportunities for formal feedback on your progress throughout the term (there are two term tests, one final exam, five Pre-lab assignments, five reports and five tutorial quizzes). Each activity should help inform you of your strengths and weaknesses but also help inform future course offerings.
- We recognize that unforeseeable events happen. If this results in you having problems meeting any of your assignment submission dates, accommodations are possible. Procedures for making these accommodations are found in the appropriate sections of the D2L website.

<u>What is expected from you:</u>

- Be respectful of everyone
- Come prepared for and be willing to participate in all class activities
- Be as organized as possible so that assignments are submitted on time
- Continually assess your performance and if you are struggling please ask or email either your instructor or TA's as soon as possible.
- In emails please use your @ucalgary.ca email address, include your name, CHEM 201 and make sure to use full sentences so that responses can be effective. Please anticipate that replies may take up to 24 hours between Monday and Friday.
- In lecture you need to make sure you understand how something is being communicated but in order to truly understand a concept YOU MUST PRACTICE and this is why suggested problems from the textbook, class homework or past examinations will be provided.

<u>Selected exercises from the textbook</u> – *use these exercises as a launching point when learning how to solve problems involving…*

<u>Stoichiometry</u>

Chapter 2: 120
Chapter 3: 2a-b
Chapter 4: 1, 6, 11, 13, 21, 41, 49, 61

<u>Atoms</u>

Chapter 6;
Odd Qs: 7, 9, 11, 27, 37, 39, 53, 57, 61, 67, 77.
Even Qs: 8, 12, 30, 68.
Chapter 7:
Odd; 1, 3, 11, 13, 15, 17, 21, 23, 25, 27, 31, 41, 43, 49, 51, 57, 67.
Even; 2, 26, 44, 46, 48.

<u>Chemical Species.</u>

Chapter 8:
Odd Qs: 5, 9, 11, 13, 17, 19, 23, 25, 33, 37, 41, 43, 45, 47, 65, 67, 69, 77, 79 and 85 (parts a through c).
Even Qs: 10, 16, 18, 62, 76.
Chapter 9:
Odd; 3, 7, 9, 11, 17, 19, 23, 35, 45, 57, 61, 69.
Even; 2, 18, 22, 54, 68.
Chapter 23
Odd: 3, 5, 7, 11 or 15, 19, 21, 27, 31, 37, 39, 41, 47, 49, 57, 61, 67, 69, 77, 83
Even: 4, 6, 12, 20, 40, 58.

<u>Nomenclature Website -</u> http://www.chem.ucalgary.ca/courses/351/WebContent/ion/orgnom/index.html

<u>Collections of Chemical Species.</u>

Chapter 11
Odd: 3, 5, 7, 17, 25, 27, 29, 43, 45, 51, 55, 61
Even: 8, 10, 18, 26, 56, 62

Course Calendar CHEM 201 – WINTER 2016: To know rooms and exact dates you will need to refer to your own schedule in PeopleSoft.

JANUARY 2016

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

FEBRUARY 2016

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

MARCH 2016

SUN	MON	TUES	WED	THUR	FRI	SAT
		1 Tutorial 3	2	3	4	5
6	7	8 Lab 4	9	10	11	12
13	14 **Term Test #2**	15 Tutorial 4	16	17	18	19
20	21	22	23	24	25 Good Friday	26
27	28 Easter Monday	29 Lab5	30	31		

APRIL 2016

SUN	MON	TUES	WED	THUR	FRI	SAT
					1	2
3	4	5 Tutorial 5	6	7	8	9
10	11	12	13 Lectures end	14	15	16
17	18 Final exams start	19	20	21	22	23
24	25	26	27	28 Final exams end	29	30 Winter term ends