

**UNIVERSITY OF CALGARY  
DEPARTMENT OF CHEMISTRY  
COURSE SYLLABUS  
SPRING 2015**

**COURSE: CHEMISTRY 201, General Chemistry: Structure & Bonding**

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL
L01	MWF	12:30-2:20	ST 131	Dr. L. Abraham	SA 156	<a href="mailto:liza.abraham2@ucalgary.ca">liza.abraham2@ucalgary.ca</a>

Course, Lab and Tutorial Coordinator: Dr. Liza Abraham (SA 156, [liza.abraham2@ucalgary.ca](mailto:liza.abraham2@ucalgary.ca))

Course website <http://d2l.ucalgary.ca>: CHEMISTRY 201: STRUCTURE & BONDING

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**Textbook references in this syllabus refer to:**

J.C. Kotz, P.M. Treichel, J.R. Townsend, *Chemistry and Chemical Reactivity*, 8<sup>th</sup> Edition. Brooks/Cole CENGAGE Learning.

**Material that is expected as background knowledge:**

Stoichiometry

Chapters 1-4

Atoms

Chapter 6 – sections 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

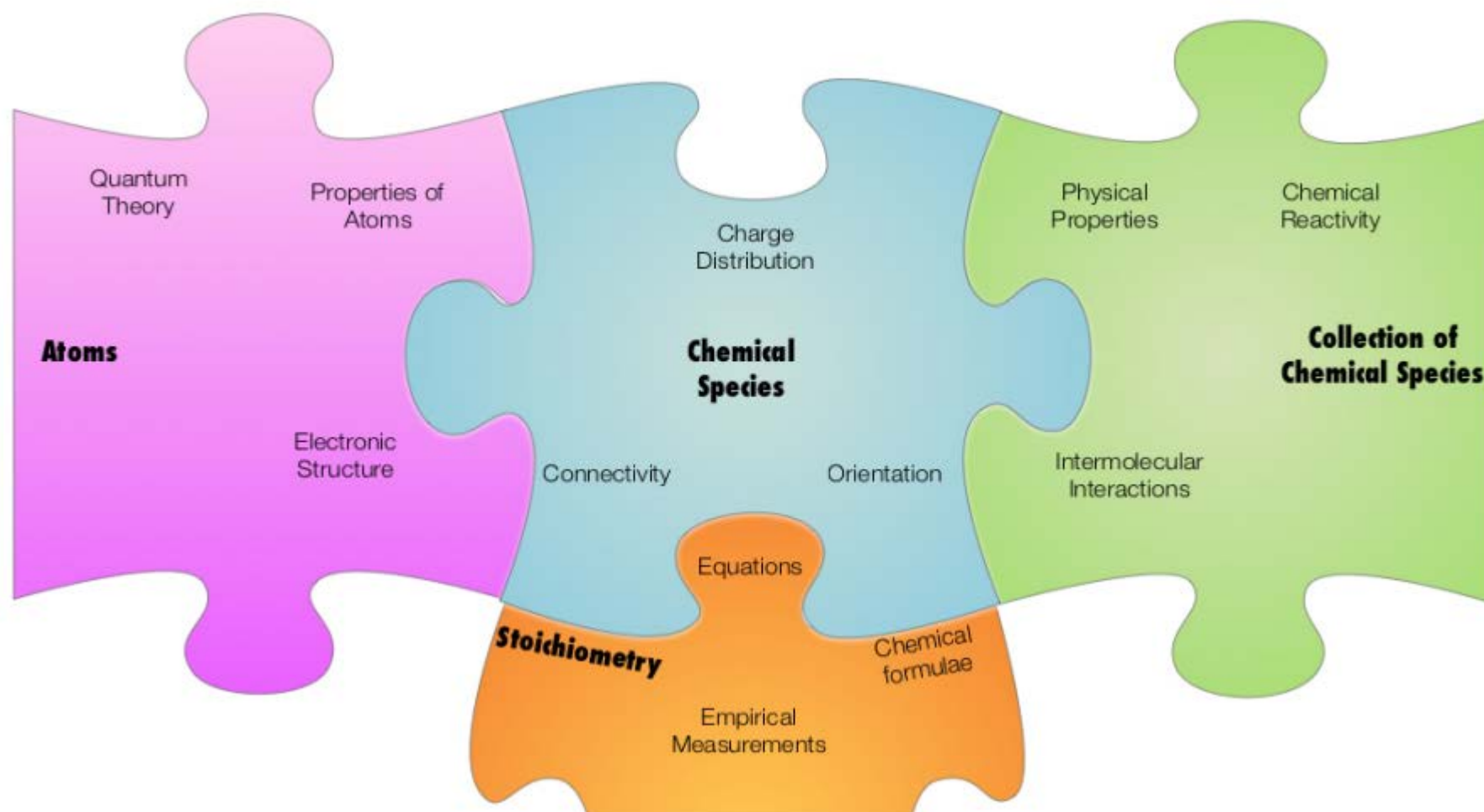
Chapter 12 – Intermolecular Forces and Liquids – all of 12.1 through 12.5

12.6 selected topics only.

Applying Structure and Bonding Concepts - Organic Chemistry

Chapter 10 – Carbon: Not Just Another Element – 10.1-10.4

**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). 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:

### 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.	<ul style="list-style-type: none"><li>-Demonstrate the relationship between frequency, wavelength and energy of light.</li><li>-Explain qualitatively how an atomic spectrum is obtained experimentally.</li><li>-Describe how the energy of e-s are quantized.</li><li>-Discriminate between the ground and an excited state for an electron in an atom.</li><li>-Explain how photons can be used to excite or remove e-s from atoms.</li><li>-Relate the energy, wavelength or frequency of any photon in an atomic spectrum to the difference between ground and excited states</li></ul>
The energy and spatial distribution of electrons in atoms is explained using Quantum Theory.	<ul style="list-style-type: none"><li>-Describe the wave character of e-s.</li><li>-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.</li><li>-Associate quantum numbers with orbitals.</li><li>-Draw the boundary, electron density and radial probability diagrams for the orbitals in the first three electron shells of an atom.</li><li>-Define the concept of a node &amp; identify node(s) within an orbital diagram.</li><li>-Draw the energy levels for the first four shells of an atom.</li><li>-Identify a possible set of quantum numbers for any e-.</li></ul>
Every element has a unique arrangement of electrons.	<ul style="list-style-type: none"><li>-Determine the ground state e- configurations for the first 36 elements using Aufbau, Pauli and Hund's principles.</li><li>-Generate e- configurations in spdf notation, using energy diagrams or orbital box diagrams, and rationalize when to use one type versus another.</li><li>-Identify and differentiate core and valence e-s -Identify excited states for atoms.</li><li>-Recognize and explain the reason for exceptions to ground state configurations.</li><li>-Determine the e- configurations for stable ions of the elements.</li></ul>
The electron configurations of atoms can be used to help explain the physical properties of the elements and their compounds.	<ul style="list-style-type: none"><li>-Identify paramagnetic and diamagnetic species.</li><li>-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 (<math>Z^*</math>).</li><li>-Explain changes in size, ionization energy and electron affinity for an atom and its ions.</li><li>-Order a given series of elements or ions by size, ionization energy and/or electron affinity then justify the answer.</li><li>-Recognize the difference between electron affinity and electron attachment enthalpy.</li></ul>

## 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.	<ul style="list-style-type: none"><li>-Define electronegativity.</li><li>-Predict and rationalize the type of bonding that occurs between atoms by using electronegativity differences.</li><li>-Describe covalent and ionic bonding.</li></ul>
Lewis diagrams show the connectivity between atoms as a result of the rearrangement of valence electrons.	<ul style="list-style-type: none"><li>-Generate valid Lewis diagrams for a set of atoms.</li><li>-Calculate formal charge within a Lewis diagram.</li><li>-Analyze Lewis diagrams to determine their validity.</li><li>-Recognize when the octet rule can be violated.</li><li>-Determine bond orders within a chemical species.</li><li>-Identify bonds of significant polarity in a chemical species.</li></ul>
Some chemical species may display resonance.	<ul style="list-style-type: none"><li>-Generate and identify valid resonance structures.</li><li>-Distinguish equivalent from non-equivalent resonance structures.</li><li>-Recognize when a chemical species is said to display resonance.</li><li>-Use curly arrows to interconvert resonance structures.</li><li>-Generate and identify a valid resonance hybrid for a set of for a set of resonance structures.</li><li>-Determine formal charges and bond orders in a resonance hybrid.</li></ul>
Regions of significant polarity can be used to identify functional groups and name a chemical species.	<ul style="list-style-type: none"><li>-Describe what makes up a functional group.</li><li>-Identify the following functional groups: alkanes, alkenes, alkynes, alcohols, ethers, carboxylic acids, esters, amines, amides, acid chlorides.</li><li>-Generate a name for organic compounds that possess only a single functional group.</li><li>-Generate a structure given a named organic compound that possesses a single functional group</li></ul>
Valence Shell Electron Pair Repulsion (VSEPR) structures show the spatial arrangement of atoms within chemical species.	<ul style="list-style-type: none"><li>-Build VSEPR diagrams from valid Lewis diagrams and vice versa.</li><li>-Build Line drawings from valid VSEPR diagrams and vice versa.</li><li>-Assign electron-pair geometry and molecular shapes to atoms bonded to two, three, four, five or six other atoms.</li><li>-Assign approximate bond angles.</li><li>-Recognize variations in orientation of VSEPR diagrams for the same geometries/shapes.</li><li>-For species that display resonance describe why resonance hybrids are used to identify &amp; draw valid VSEPR diagrams.</li></ul>
The same number and type of atoms can connect and orient themselves in space in several different ways, which results in isomerism.	<ul style="list-style-type: none"><li>-Recognize constitutional, conformational, geometric and optical isomerism.</li><li>-Generate constitutional, conformational, geometric and optical isomers for a given set of atoms.</li><li>-Identify chiral centers.</li></ul>
Valence Bond (VB) and Molecular Orbital (MO) theories are used to explain the spatial arrangement of bonding.	<ul style="list-style-type: none"><li>-Contrast VB and MO Theories.</li><li>-Draw the energy diagrams for unhybridized and hybridized atoms.</li><li>-Draw the sigma and pi overlaps for a chemical species.</li><li>-Name hybridized orbitals and orbital overlaps according to VBT.</li><li>-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.</li></ul>
The spatial arrangement of atoms determines the charge distribution of a chemical species.	<ul style="list-style-type: none"><li>-Distinguish between bond polarities, and molecular polarity.</li><li>-Determine the overall molecular polarity of a chemical species.</li><li>-Identify polar and non-polar molecules.</li></ul>

## 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.	<ul style="list-style-type: none"><li>-Explain the nature of the forces between chemical species.</li><li>-Identify and differentiate the types of forces that exist between chemical species.</li><li>-Explain how the strength of intermolecular interactions differ for a solid, liquid and gas.</li><li>-Identify the intermolecular forces present within a collection of chemical species (pure samples and mixtures).</li></ul>
The physical properties and chemical reactivity of substances depend on the intermolecular interactions between chemical species.	<ul style="list-style-type: none"><li>-Understand the difference between a physical and chemical change.</li><li>-Use intermolecular interactions to explain or predict relative boiling points, viscosities, surface tension, wetting and diffusion rates for two different pure substances.</li><li>-Use intermolecular interactions to explain or predict solubility or mixing.</li><li>-Use intermolecular interactions to rationalize why molecules react at the site of functional groups.</li><li>-Use curly arrows and Lewis diagrams to explain bond breaking and bond making.</li></ul>

## **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 Monocle for in-class polling is designed to help inform you on the spot about your strengths and weaknesses in knowledge or its application and inform Dr. Abraham 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:**

### What you can expect from this course

- I will try to help you as much as possible. Do not be afraid to contact me after class or by email (liza.abraham2@ucalgary.ca).
- You will have several opportunities for formal feedback on your progress throughout the term (there will be three in-class assignments, one term test, one final exam, five pre-lab assignments, five laboratory 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.

### What is expected from you

- 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, however, please include your name and make sure to use full sentences so that responses can be effective. Please anticipate that replies may take up to 12 hours.
- 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.

**Selected exercises from the textbook** – use these exercises as a launching point when learning how to solve problems involving...

Stoichiometry

Chapter 2: 120  
Chapter 3: 2a-b  
Chapter 4: 1, 6, 11, 13, 21, 39, 47, 59

Atoms

Chapter 6:  
Odd Qs: 7, 9, 11, 27, 37, 39, 53, 57, 61, 67, 69, 77.  
Even Qs: 8, 12, 30, 68.  
Chapter 7:  
Odd Qs: 1, 3, 11, 13, 15, 17, 21, 23, 25, 27, 31, 35, 37, 43, 45, 51, 57, 59.  
Even Qs: 2, 26, 38, 40, 42.

Chemical Species.

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 Qs: 3, 7, 9, 11, 19, 21, 25, 35, 45, 57, 61, 69.  
Even Qs: 2, 20, 24, 60, 74.  
Chapter 10:  
Odd Qs: 3, 5, 7, 11 or 15, 19, 21, 27, 31, 37, 39, 41, 47, 49, 57, 61, 67, 69, 77, 83  
Even Qs: 4, 6, 12, 20, 40, 58

**Nomenclature Website** - <http://www.chem.ucalgary.ca/courses/351/ION-v02/>

Collections of Chemical Species.

Chapter 12:  
Odd Qs: 3, 5, 7, 17, 25, 27, 29, 43, 45, 51, 55, 61  
Even Qs: 8, 10, 18, 26, 46, 56, 62

## Course Calendar CHEM 201 – SPRING 2015:

### MAY 2015

SUN	MON	TUES	WED	THUR	FRI	SAT
3  10  17  24					1	2
	4	5	6	7	8	9
	11	12	13	14	15 <b>Lectures Start</b>	16
	18 <b>VICTORIA DAY</b>	19	20 <b>LAB 1</b>	21 <b>LAB 1</b>	22	23
	25 <b>TUTORIAL 1</b>	26 <b>TUTORIAL 1</b>	27 <b>LAB 2</b>	28 <b>LAB 2</b>	29 <b>Term test 1</b>	30

### JUNE 2015

	MON	TUES	WED	THUR	FRI	SAT
31	1 <b>TUTORIAL 2</b>	2 <b>TUTORIAL 2</b>	2 <b>LAB 3</b>	3 <b>LAB 3</b>	5	6
7	8 <b>TUTORIAL 3</b>	9 <b>TUTORIAL 3</b>	9 <b>LAB 4</b>	10 <b>LAB 4</b>	12 <b>Term Test 2</b>	13
14	15 <b>TUTORIAL 4</b>	16 <b>TUTORIAL 4</b>	17 <b>LAB 5 &amp; Checkout</b>	18 <b>LAB 5 &amp; Checkout</b>	19	20
21	22 <b>TUTORIAL 5</b>	23 <b>TUTORIAL 5</b>	24 <b>Last Day of Lecture</b>	25	26	27

To know rooms and exact dates for Tutorial/ Lab activities, you will need to refer to your own schedule in PeopleSoft.