UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
SPRING 2018

1. **Course: CHEMISTRY 201, General Chemistry: Structure & Bonding**

LEC	DAYS	TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	12:00-13:50	EEEL 161	Dr. Bronwen Wheatley	SA 156	bmmwheat@ucalgary.ca	by appointment

See Dr. Wheatley for lecture and lab coordination.

Tutorials begin Monday, May 14th; labs begin Wednesday, May 16th, 2018.

D2L site: CHEM 201 L01 - (Spring 2017) - General Chemistry: Structure and Bonding

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 focusing on an exploration of the fundamental links between electronic structure, chemical bonding, molecular structure and the interactions of molecules using inorganic and organic examples.

3. **Recommended Textbook:** J.C. Kotz, P.M. Treichel, J.R. Townsend, D.A. Treichel, Chemistry and Chemical Reactivity, 9th Edition. Brooks/Cole CENGAGE Learning.

4. **Topics Covered and Suggested Readings:**

Course Contents	**Chapter in Textbook** *(not all sections will be covered)*
Atoms	Chapters 6-7

Demonstrate the relationship between frequency, wavelength and energy of light.
Explain qualitatively how an atomic spectrum is obtained experimentally.
Describe how the energy of an e- is 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.
Draw the energy levels for the first four shells of an atom.
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 and valence e-s.
dentify the electron configuration for isoelectronic species, excited states and stable ions of the elements.
Recognize and explain the reason for exceptions to ground state configurations.
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.
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.
Identify a possible set of quantum numbers for any orbital or e-.
Draw the boundary, electron density and radial probability diagrams for the orbitals in the first three electron shells of an atom.
Define and identify node(s) within an orbital diagram.

Chemical Species Chapters 8-9

Define electronegativity.
Predict and rationalize the type of bonding that occurs between atoms by using electronegativity differences.
Describe covalent and ionic bonding.
Generate valid Lewis diagrams for a chemical formula or condensed formula and vice versa.
Demonstrate how to determine formal charges of each atom in a valid Lewis diagram.
Analyze Lewis diagrams to determine their validity.
Recognize when the octet rule can be violated.
Determine bond orders within a chemical species and relate them to bond strength and length.
Identify bonds of significant polarity in a chemical species.
Generate, identify and rank the stability of valid resonance structures.
Distinguish equivalent from non-equivalent resonance structures.
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.
Build VSEPR diagrams from valid Lewis diagrams or resonance hybrids 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.
Distinguish between bond polarities, and molecular polarity.
Determine the overall molecular polarity of a chemical species.
Identify polar and non-polar molecules.
Recognize and generate constitutional, conformational, geometric and optical isomerism for a given set of atoms.
Identify chiral centers.
recognize that stereoisomerism needs to be identified in the name of the structure.
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.
Illustrate how atomic orbitals combine to give molecular orbitals.
Name the molecular orbitals for bonding and antibonding interactions in MOT.

Collections of Chemical Species Parts of Chapter 11

Explain the nature of the forces between chemical species.
Identify and differentiate the types of forces exist within pure samples and mixtures.
Explain how the strength of intermolecular interactions differ for a solid, liquid and gas.
Understand the difference between a physical and chemical change.
Use intermolecular interactions to explain or predict relative boiling points, viscosities, surface tension, liquid/solid surface interactions, diffusion rates, and miscibility/solubility for two different pure substances.
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.

Application: Organic Chemistry Part of Chapter 23

For a chemical species, identify its functional group(s) (alkanes, alkenes, alkynes, alcohols, ethers, aldehyde, and ketone) and/or determine its IUPAC name based on structure or vice versa.

Have an appreciation for how organic chemistry is an expansion of structure and bonding as found in CHEM 201.

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

    1. Determination of percent by mass of $NaHCO_3$ in Alka-Seltzer® tablets

        - Stoichiometry & Previous background knowledge review (Chapter 4)

    2. Investigating the contents of lemonade: determining the amount of Vitamin C & Citric Acid present

        -Topics: Titration (Chapter 4) Lewis & Functional Groups (Chapters 8 & 23)

    3. Synthesis of Cholesterol Nonanoate and Preparation of a Liquid Crystal Display (LCD)

        -Topic: VSEPR & Line Drawings (Chapters 4, 8 & 23)

    4. Investigating Isomers: A look at how Maleic Acid can be Isomerized to Fumaric Acid.

        -Topic: Isomers, Molecular Polarity & VSEPR (Chapters 4, 8 & 23)

    5. Structure and Physical Properties of Compounds

        -Topic: Intermolecular Forces (Chapter 11)

6. **Tutorial Activities:** (5 weeks, 1.5 hours/ week)

    1. Atomic Properties (Chapter 6 & 7)
    2. Lewis Structures (Chapter 8)
    3. VSEPR Structures (Chapter 8)
    4. Isomers (Chapter 8 & Chapter 23)
    5. Valence Bond Theory (Chapter 9)

Department Approval: Approved by Department Head Date: May 3, 2018