FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS

## 1. Course: CHEMISTRY 201, General Chemistry: Structure and Bonding – Winter 2021

| **Coordinators:** | **Email** | **Office Hours** |
|---|---|---|
| Dr. Vivian Mozol | vjmozol@ucalgary.ca | WF 12:00-1:00pm |
| Dr. Bronwen Wheatley | bmmwheat@ucalgary.ca | by appointment, please email |

**Lecture 01 MWF 11:00 - 11:50am – Online**

| **Instructor** | **Email** | **Office Hours** |
|---|---|---|
| Dr. Pierre. Kennepohl | pierre.kennepohl@ucalgary.ca | MWF 12:00-1:00pm - SB 231 |

**Lecture 02 TR: 8:00 - 9:15am – Online**

| **Instructor** | **Email** | **Office Hours** |
|---|---|---|
| Dr. Vivian Mozol | vjmozol@ucalgary.ca | WF 12:00-1:00pm - Online |

Lab Activities start the week of January 18th, 2021
Tutorial Activities start the week of January 25th, 2021
Course website d2l.ucalgary.ca: CHEM 201 – ALL - (Winter 2021) - General Chemistry: Structure and Bonding
Departmental Office: 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 electronic structure, chemical bonding, molecular structure and the interactions of molecules using inorganic and organic examples.

## 3. Textbook references in this syllabus refer to:

OpenStax: Chemistry: https://openstax.org/details/books/chemistry

## 4. Topics Covered and Suggested Readings:

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

Stoichiometry
Chapters 1-4.

**Chapter coverage in Chemistry 201:**

Describe the basic connectivity for chemical species
- Chapter 6 – Electronic Structure & Periodic Properties of Elements – 6.4 and 6.5.
- Chapter 7 – Chemical Bonding and Molecular Geometry – 7.1 through 7.4.

Describe the 3D shape of polyatomic chemical species
- Chapter 6 – Electronic Structure & Periodic Properties of Elements – 6.3.
- Chapter 7 – Chemical Bonding and Molecular Geometry – 7.6.
- Chapter 8 – Advanced Theories of Covalent Bonding – 8.1 through 8.3.

Structurally explain the physical and chemical changes of chemical species.
- Chapter 7 – Chemical Bonding and Molecular Geometry – 7.6.
- Chapter 10 – Liquids & Solids – 10.1 and 10.2.

**5. Lab Activities (5 weeks, 3 hours every other week starting week of January 18th, 2021)**

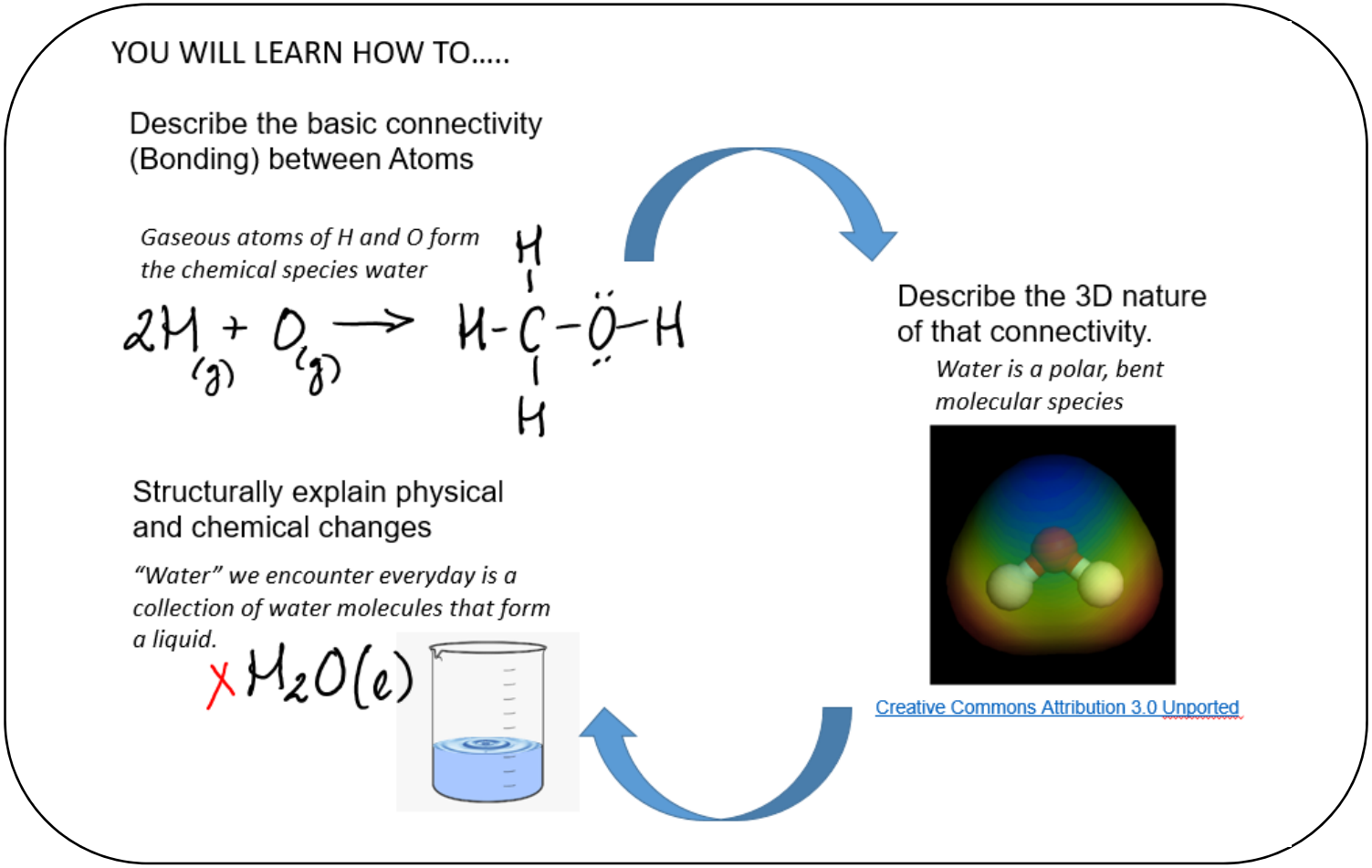
All activities will focus on developing students skills related to the collection and analysis of observations taken during experiential chemical activities.

**6. Tutorial Activities (5 weeks, 1.5 hours every other week starting week of January 25th, 2021)**

1. **Electron Configurations and Periodic Properties** (Chapter 6)
2. **Lewis Structures** (Chapter 7)
3. **VSEPR** (Chapter 7)
4. **Bonding Theories** (Chapter 8)
5. **Putting it all together** (Chapters 7 and 8)

Department Approval: Date:

**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 (Electronic Structure of Atoms, Structure and Bonding of individual Chemical Species and Structure and Bonding of Collections of Chemical Species). Through required skills and earning outcomes you will develop your critical thinking, observational and visualization skills, to enable you to discuss the structure and bonding of chemical substances within any discipline.



## Pre-requisite review material:

***All of the stoichiometry learning objectives below are a **REVIEW** of CHEM 20/30 & will **NOT** be addressed in lecture. These objectives may be applied within the laboratory component of the course during analysis of observations. There is a review quiz of this material posted on D2L under *Prerequisite Chemistry Review*, along with links & references to relevant textbook sections to help you make sure you are up to speed with the review material.***

**STOICHIOMETRY •** Examine the stoichiometry of physical and chemical changes.

| **Enduring Understanding** | **Learning Outcomes *** What you should be able to do…** | **Textbook References** Consider all questions related to chapters to be relevant review |
|---|---|---|
| Chemists describe chemical species using chemical formulae. | -Associate the chemical symbol to the name of the elements in the first 5 periods of the periodic table (H to Xe).<br>-Determine the chemical formula of a chemical species from its Lewis structure.<br>-Determine the molar mass of a chemical species. | Chapter 2.3<br>Chapter 2.4*<br>Chapter 3.1 |
| 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).<br>-Identify the limiting and excess reagents given experimental data.<br>-Determine the theoretical and percent yield of a chemical reaction. | Chapter 4.1**<br>Chapter 4.3 & 4.4 & 4.5*** |
| 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.<br>-Convert between magnitude of measurement units commonly used in the metric system: kilo, deci, milli, micro, nano and pico.<br>-Perform dilution calculations and determine the consequences of using dilute vs. concentrated solutions. | Chapter 3.3<br>Chapter 3.4 |

* Also see: Test your understanding on Chemical Formulae D2L quiz
** Also see: Test understanding on balancing equations D2L quiz
*** Also see: Test your understanding on limiting reagent, theoretical yield & percent yield D2L quiz

**Course aims and objectives:**

## CHEM 201:

This section lists the Learning Outcomes for the Enduring Understandings that you should have by the end of this course. There is one overarching understanding and three conceptual understandings related to Structure and Bonding.

### OVERARCHING UNDERSTANDING

| by the end of the course you will understand… | What you will be able to do… |
|---|---|
| Visualization is crucial to understanding the structure and bonding of chemical species<br>Drawings, molecular & conceptual models and observations are tools of visualization<br>Many visualizations have both static and dynamic components | When explaining any chemical concept or you will…<br>-identify and/or generate the necessary 2D and/or 3D drawings<br>-utilize molecular & conceptual models<br>-make appropriate observations<br>-recognize and identify the static and/or dynamic components of drawings and models |

### THE BASIC CONNECTIVITY FOR CHEMICAL SPECIES USES/DEMONSTRATES THE FOLLOWING SKILLS/LEARNING OUTCOMES

| Skills/Learning Outcomes | Textbook References |
|---|---|
| LO 1 Determine electron configurations and identify valence electrons for the first 36 elements. | Chapter 6.4 |
| LO 2 Describe and rationalize the periodic properties of the first 36 elements. | Chapter 6.5* |
| LO 3 Describe and use electronegativity to predict or explain the type of bonding established between two atoms. | Chapter 7.1 |
| LO 4 Describe covalent, polar covalent, and ionic bonding. | Chapter 7.2 |
| LO 5 Draw and/or Recognize valid and complete Lewis diagrams including all non-zero formal charges. | Chapters 7.2, 7.3 |
| LO 6 Describe and Use the relationship between bond order and bond lengths in molecules. | Chapter 7.2 |
| LO 7 Recognize and rank valid resonance structures for chemical species. | Chapter 7.4 |
| LO 8 Draw and/or Recognize valid resonance hybrids for chemical species. | Chapter 7.4 |
| LO 9 Recognize and fix short forms for the representation of chemical structures. | Not explicitly in text |

* Also see: Atomic Properties Test your understanding quiz in D2L

**Course aims and objectives:**

## THE 3D SHAPE OF POLYATOMIC CHEMICAL SPECIES USES/DEMONSTRATES THE FOLLOWING SKILLS/LEARNING OUTCOMES

| Skills/Learning Outcomes | Textbook References |
|---|---|
| LO 10 Determine the VSEPR Electronic Geometries for all atoms surrounded by 2 to 6 other atoms based on a Lewis Diagram or Resonance Hybrid. | Chapter 7.6 |
| LO 11 Convert VSEPR Electronic Geometries to Molecular Geometries. | Chapter 7.6 |
| LO 12 Draw Perspective Diagrams from valid VSEPR diagrams and vice versa. | Not explicitly in text |
| LO 13 Describe and predict approximate the bond angles in a chemical species. | Chapter 7.6 |
| LO 14 Draw and recognize the shapes of valence atomic orbitals | Chapter 6.3 |
| LO 15 Use Valence Bond Theory to rationalize how atomic orbitals overlap to form bonds in 3D space. | Chapter 8.2, 8.3 |
| LO 16 Use Molecular Orbital Theory to rationalize how atomic orbitals overlap to form bonds in 3D space. | Chapter 8.1 |
| LO 17 Compare and contrast VBT and MOT. | Not explicitly in text |

## EXPLANATIONS FOR PHYSICAL AND CHEMICAL CHANGES INVOLVING CHEMICAL SPECIES USES/DEMONSTRATES THE FOLLOWING SKILLS/LEARNING OUTCOMES

| Skills/Learning Outcomes | Textbook References |
|---|---|
| LO 18 Determine the charge distribution in a chemical species. | Chapter 7.6 |
| LO 19 Identify intermolecular interactions between chemical species. | Chapter 10.1 |
| LO 20 Explain the difference between a physical change and a chemical change. | Chapter 10.2 |

## Format and Procedures:

To create strong online communities there is a strong emphasis on group work in all components of this course (lecture, tutorial, lab). What will be learned at the start of the course will be continually applied throughout the term, which means final exam will cumulatively assess ALL understandings. Whenever possible, videos of chemical reactions coupled with group discussion will highlight the experiential nature of the discipline.

The use of TopHat for in-class polling is optional BUT it is designed to help inform you AND your instructor about your strengths and weaknesses in knowledge, or its application. Please use it. It will help inform your instructor how to pace coverage of course material.

Your grade is calculated using assessment of work you upload (as doc pdf or image files) to a D2L Dropbox or Quiz, and relevant auto-graded questions within D2L quizzes.

## Responsibilities and Expectations:

Working online means you need to be aware of academic integrity.

- Any work done/submitted for this course MUST be your own or a collaborative effort by you and other members of this class as indicated. Please visit https://www.ucalgary.ca/student-services/student-success/learning/academic-integrity

What is expected from you in the online environment:

- Be respectful of everyone. Prior to a class you may use chat to talk with friends or other class members. But, once a Zoom session starts please use the chat box only for course related questions.
- Come prepared for and be willing to participate in all class activities.
- Be as organized as possible so you submit assignments on time.
- During a Zoom session, please inform your instructor/TA if the learning outcomes they are trying to communicate are unclear. To understand those learning outcomes, however, YOU MUST PRACTICE. Suggested problems or class homework will be made available in D2L.
- Continually assess your performance. If you are struggling, please contact either your instructor or TA as soon as possible.
- Please use your @ucalgary.ca email address for all emails. 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.

What you can expect from the course and your instructors:

- The opportunities for formal feedback on your progress throughout the term include five lab activities and five tutorial activities. Make sure you use the feedback you get to reflect on your strengths and weaknesses, to determine what you should change to improve your performance.
- We recognize that unforeseeable events happen. If this results in you having problems meeting any of your assignment submission dates, accommodations are possible. Details are in the course outline posted on the D2L website.
- The instructor and TA's will try to help as much as possible. Do not be afraid to contact them. Their contact information is available on the course homepage. However, remember their help focuses on developing your own understandings of the course content.

## CHEM 201 – **TENTATIVE** WEEKLY SCHEDULE

This schedule gives the *weekly* timing for the coverage of the *learning outcomes* during the lecture portion this course.
**Because this schedule is tentative, D2L updates of learning outcomes will be given regularly at the end of each week.**

**It also identifies the *weekly occurrence of any Lab* (dark blue) *and Tutorial* (lighter blue) Activity.**

- For the timing of your exact Lecture, Lab and Tutorial you will need to refer to YOUR Student Center weekly schedule.
- **The week of March 29th the Tutorial on Friday at 8am will be moved to Wednesday at 8am**. If you are unable to attend this modified timeslot please inform the Tutorial coordinator ASAP (Dr. Mozol, vjmozol@ucalgary.ca).

### JANUARY 2021

| SUN | MON | TUES | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|
| | | | | | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11<br>Lectures begin<br>**Lecture: The basic connectivity for chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 1 Determine electron configurations and identify valence electrons for the first 36 elements. | 12 | 13 | 14 | 15 | 16 |
| 17 | 18<br>**Lab 1**<br>TBA<br>**Lecture: The basic connectivity for chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 2 Describe and rationalize the periodic properties of the first 36 elements.<br>LO 3 Describe and use electronegativity to predict or explain the type of bonding established between two atoms.<br>LO 4 Describe covalent, polar covalent, and ionic bonding. | 19 | 20 | 21<br>Last day to drop | 22<br>Last day to add or swap | 23 |
| 24 | 25<br>Tut 1<br>Electron configuration and periodic properties<br>**Lecture: The basic connectivity for chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 5 Draw and/or Recognize valid and complete Lewis diagrams including all non-zero formal charges.<br>LO 6 Describe and Use the relationship between bond order and bond lengths in molecules. | 26 | 27 | 28 | 29 | 30 |

## FEBRUARY 2021

| SUN | MON | TUES | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|
| 31 | 1<br>**Lab 2**<br>TBA<br>**Lecture: The basic connectivity for chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 7 Recognize and rank valid resonance structures for chemical species.<br>LO 8 Draw and/or Recognize valid resonance hybrids for chemical species.<br>t | 2 | 3 | 4 | 5 | 6 |
| 7 | 8<br>**Tut 2**<br>Lewis structures<br>**Lecture: The basic connectivity for chemical species uses/demonstes the following skills**<br>LO 9 Recognize and fix short forms for the representation of chemical structures.<br>**The 3D shape of polyatomic chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 10 Determine the VSEPR Electronic Geometries for all atoms surrounded by 2 to 6 other atoms based on a Lewis Diagram or Resonance Hybrid.<br>LO 11 Convert VSEPR Electronic Geometries to Molecular Geometries.<br>LO 12 Draw Perspective Diagrams from valid VSEPR diagrams and vice versa.<br>LO 13 Describe and predict approximate the bond angles in a chemical species.<br>s | 9 | 10 | 11 | 12 | 13 |
| 14 | 15<br>*Family Day*<br>**Reading Week no lectures labs or tutorials** | 16<br>. | 17 | 18 | 19 | 20 |
| 21 | 22<br>**Lab 3**<br>TBA<br>**Lecture: The 3D shape of polyatomic chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 10 Determine the VSEPR Electronic Geometries for all atoms surrounded by 2 to 6 other atoms based on a Lewis Diagram or Resonance Hybrid.<br>LO 11 Convert VSEPR Electronic Geometries to Molecular Geometries.<br>LO 12 Draw Perspective Diagrams from valid VSEPR diagrams and vice versa.<br>LO 13 Describe and predict approximate the bond angles in a chemical species. | 23 | 24 | 25 | 26 | 27 |

## MARCH 2021

| SUN | MON | TUES | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|
| 28 | 1<br>Tut 3<br>VSEPR theory<br>**Lecture: The 3D shape of polyatomic chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 14 Draw and recognize the shapes of valence atomic orbitals<br>LO 15 Use Valence Bond Theory to rationalize how atomic orbitals overlap to form bonds in 3D space. | 2 | 3 | 4 | 5 | 6 |
| 7 | 8<br>Lab 4<br>TBA<br>**Lecture: The 3D shape of polyatomic chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 15 Use Valence Bond Theory to rationalize how atomic orbitals overlap to form bonds in 3D space. | 9 | 10 | 11 | 12 | 13 |
| 14 | 15<br>Tut 4<br>Bonding theories<br>**Lecture: The 3D shape of polyatomic chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 16 Use Molecular Orbital Theory to rationalize how atomic orbitals overlap to form bonds in 3D space. | 16 | 17 | 18 | 19 | 20 |
| 21 | 22<br>Lab 5<br>TBA<br>**Lecture: The 3D shape of polyatomic chemical species uses/demonstrates the following skills/learning outcomes**<br>LO 16 Use Molecular Orbital Theory to rationalize how atomic orbitals overlap to form bonds in 3D space.<br>LO 17 Compare and contrast VBT and MOT. | 23 | 24 | 25 | 26 | 27 |
| 28 | 29<br>Tut 5<br>Putting it all together<br>**Due to Good Friday, Friday 8am Tutorial will be moved to Wednesday at 8am (T07A, T07B, T07C become T03D, T03E, & T03F)**<br>**Lecture: Explanations for physical and chemical changes of chemical species uses/demonstrates the following skills.**<br>LO 18 Determine the charge distribution in a chemical species.<br>LO 19 Identify intermolecular interactions between chemical species. | 30 | 31 | 1 | 2<br>*Good Friday* | 3 |

## APRIL 2021

| SUN | MON | TUES | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|
| 4 | 5<br>*Easter Monday* | 6<br>**Lecture: Explanations for physical and chemical changes of chemical species uses/demonstrates the following skills.**<br>LO 19 Identify intermolecular interactions between chemical species.<br>LO 20 Explain the difference between a physical change and a chemical change. | 7 | 8<br>. | 9 | 10 |
| 11 | 12<br>**Lecture: Review** | 13 | 14 | 15<br>**Last Day of Classes**<br>**Last Day to Withdraw** | 16 | 17 |
| 18 | 19<br>**Exams Begin** | 20<br>. | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29<br>**Exams End** | 30 | |