UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
SPRING 2020

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

Lecture 01: WF 12:00 - 13:50 – Online https://ucalgary.zoom.us/j/94447251808

Instructor	**Email**	**Office Hours**
Dr. V. Mozol	vjmozol@ucalgary.ca	Fridays 9-10am and 2-3pm

Tutorials and Lab Activities start the week of May 11th, 2020
Course website d2l.ucalgary.ca: CHEM 201 – L01 - (Spring 2020) - 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:

Atoms
Chapter 6 – Electronic Structure & Periodic Properties of Elements – majority, to the depth addressed in lecture.

Chemical Species
Chapter 7 – Chemical Bonding and Molecular Geometry – All sections
Chapter 8 – Advanced Theories of Covalent Bonding – All sections

Collections of Chemical Species
Chapter 10–Liquids & Solids
10.1 Intermolecular Forces
10.2 Properties of Liquids

Applying Structure and Bonding Concepts - Organic Chemistry
Chapter 20 – Organic Chemistry – majority, to the depth addressed in lecture. Identifying functional groups, isomerization and intermolecular forces in chemical reactivity.

5. Lab Activities (5 weeks, 2 hours every week)

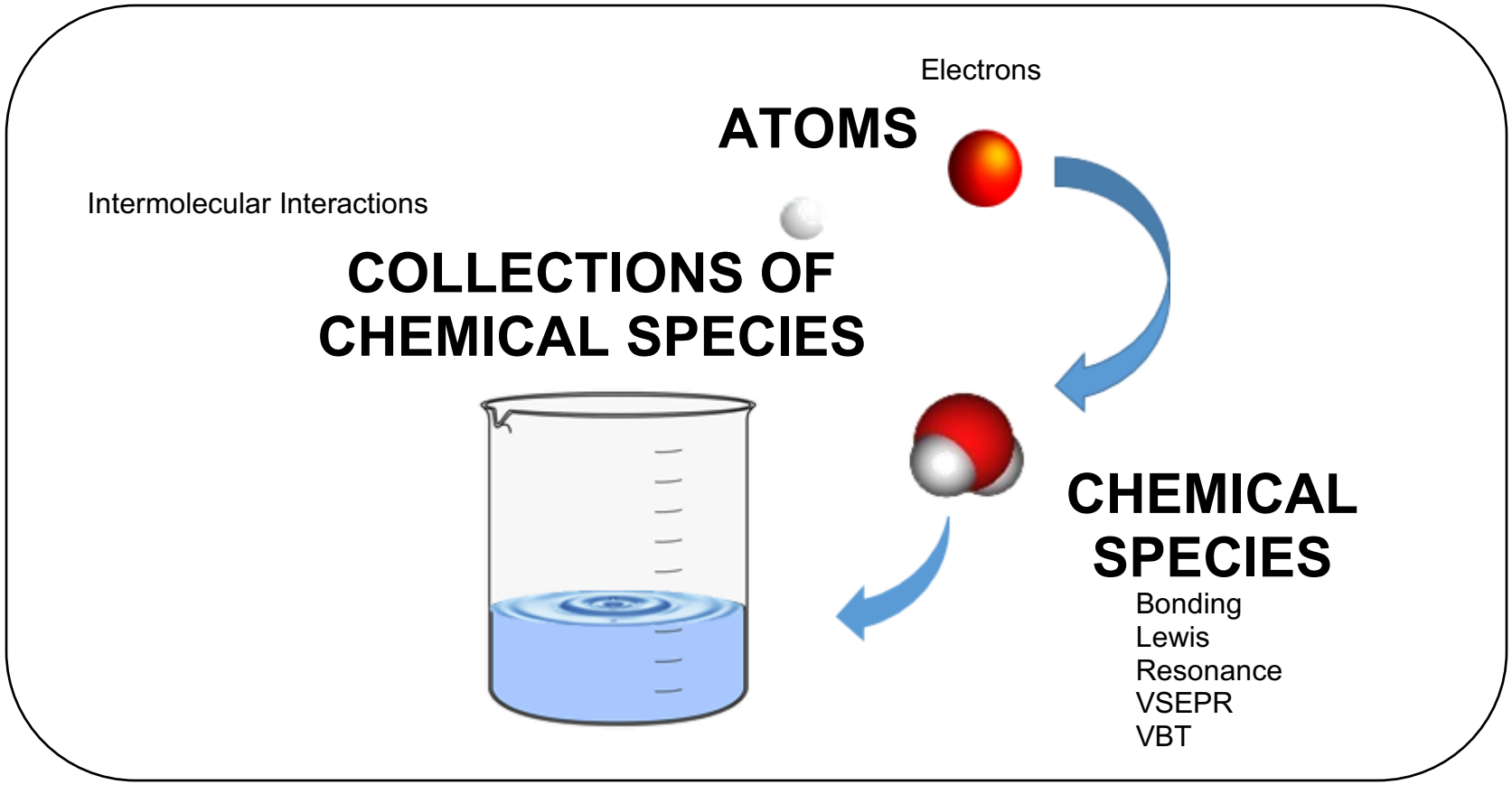
All activities will focus on developing students skills related to the collection and analysis of observations taken during experiential chemical activities.

6. Tutorial Activities (5 weeks, 1.5 hours every other week)

1. **Electron Configurations** (Chapter 6)
2. **Lewis Structures** (Chapter 7)
3. **Resonance Structures** (Chapter 7)
4. **VSEPR and Charge Distribution** (Chapter 7)
5. **Valence Bond Theory** (Chapter 8)

Department Approval: Electronically Approved Date: April 30, 2020

Rationale for the course: Chemical reactivity is important across a broad set of disciplines and requires visualization skills. 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 infographic shown below is a basic skeleton, and becomes more detailed as the semester progresses. Through the learning objectives, for the course components (tutorial, lab and lecture) you will gain critical thinking, observational and visualization skills, which will enable you to discuss the structure and bonding of chemical substances within YOUR discipline.....how cool is that!



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 & Sapling problem sets to help you make sure you are up to speed with the review material.

STOICHIOMETRY • Examine the stoichiometry of physical and chemical changes.

Enduring Understandings 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…**	**Textbook References ◊**	**Suggested Practice Questions**
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). -Determine the chemical formula of a chemical species from its Lewis structure. -Determine the molar mass of a chemical species.	Chapter 2.3 Chapter 2.4* Chapter 3.1	11, 13 & 15. 27, 29, 33, 35 5, 13, 15, 17, 19, 21, 29, 31
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.	Chapter 4.1** Chapter 4.3 & 4.4 & 4.5***	1, 3, 8, 11 47, 49, 51, 57, 61, 65, 67, 69, 71, 73, 75, 79, 81, 87, 89, 91 & 92.
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.	Chapter 3.3 Chapter 3.4	45-63, 67 71

◊ For recommended practice questions all odd numbered questions have answers in the book. Any even number question will be addressing the same learning objective(s) as the odd numbered questions nearby, so if you understand the odd numbered question, you should be able to extrapolate what the answer should be for the even numbered question next to it. If for any reason, there is confusion, please do not hesitate to contact your instructor or TA.

* 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:

Our Journey through CHEM 201:
Use the infogram on the previous page, when looking at the contents of the next three pages, to build links that show how different course concepts relate or depend on one another.

VISUALIZATION • Develop visual skills necessary to fully understand and communicate about the lecture, tutorial and laboratory content of CHEM 201.

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

ATOMS • Describe how electrons are arranged in atoms and how this arrangement can be used to help explain the physical properties of the elements.

What you will understand by the end of the course…	What you will be able to do by the end of the course…	Textbook References	Suggested Practice Questions
ELECTRONS Every element has a unique arrangement of electrons.	LO 1 Generate ground state electron configurations for elements 1-20 using energy diagrams, orbital box diagrams or *spdf* notation and rationalize when to use one type of visualization versus another.	Chapter 6.4	46, 47, 48(a,b), 49(a,b), 50, 51, 52 (a,b), 53(a,b, d challenge) 54(a-d), 58-61, 64 (a-d), 65
Some electrons are more reactive than other electrons.	LO 2 Identify and differentiate between core and valence electrons.		
	LO 3 Rationalize ionization energy, electron affinity of atoms by considering the energy of the valence e-s (n, related to how far from the nucleus they are) and the pull of the nucleus on these electrons (Z_{eff}).	Chapter 6.5*	67-74, 79 (challenge), 80

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

Course aims and objectives:

CHEMICAL SPECIES • Generate Lewis & VSEPR diagrams and use bonding theories to describe/evaluate the connectivity between atoms and spatial arrangement of bonding..

What you will understand by the end of the course…	What you will be able to do by the end of the course…	Textbook References	Suggested Practice Questions
BONDING Bonding involves the rearrangement of valence electrons.	LO 4 Define electronegativity. LO 5 Predict and rationalize the type of bonding that occurs between atoms by using electronegativity differences. LO 6 Describe covalent and ionic bonding.	Chapter 7.1 Chapter 7.2	1, 3, 5 (a-e), 7 (e,g,h), 8 (a-e), h, 9 (a, d, f) 11-17, 19 (challenge), 20-22
LEWIS Lewis diagrams show the connectivity between atoms resulting from the rearrangement of valence electrons.	LO 7 Generate valid Lewis diagrams for a chemical formula or condensed formula and vice versa. LO 8 Recognize when the octet rule is broken. LO 9 Demonstrate how to determine formal charges of each atom in a valid Lewis diagram. LO 10 Analyze the validity of Lewis diagrams. LO 11 Determine bond orders within a chemical species relating them to bond strength & length.	Chapter 7.3 Chapter 7.4 Chapter 7.5 Chapter 7.2	23-43 (odd numbered Qs) 51-54, 56-59 64, 73 19-22
RESONANCE Some chemical species may display resonance.	LO 12 Generate, identify and rank the stability of valid resonance structures. LO 13 Distinguish equivalent from non-equivalent resonance structures. LO 14 Use curly arrows to interconvert resonance structures. LO 15 Generate and identify a valid resonance hybrid, which includes formal charges and bond orders, for a set of resonance structures.	Chapter 7.4	44-49, 55, 62
VSEPR Valence Shell Electron Pair Repulsion (VSEPR) structures show the spatial arrangement of atoms within chemical species.	LO 17 Build VSEPR diagrams from valid Lewis diagrams or resonance hybrids and vice versa. LO 18 Build Line drawings from valid VSEPR diagrams and vice versa. LO 19 Assign electron-pair geometry and molecular shapes to atoms bonded to two, three, four, five or six other atoms. LO 20 Assign approximate bond angles. LO 21 Recognize variations in orientation of VSEPR diagrams for the same geometries/shapes.	Chapter 7.6	85-95, 105-110, 113-116.
CHARGE The spatial arrangement of atoms determines the charge distribution of a chemical species.	LO 22 Distinguish between bond polarities, and molecular polarity. LO 23 Determine the overall molecular polarity of a chemical species. LO 24 Identify polar and non-polar molecules.	Chapter 7.6	97-103, 113
BONDING THEORES Valence Bond Theory (VBT) and Molecular Orbital Theory (MOT) explain the spatial arrangement of bonds.	LO 25 Describe what an orbital is. LO 26 Draw the boundary diagrams for s and p-type orbitals. LO 27 Contrast VBT and MOT. LO 28 Using VBT draw the energy diagrams for un-hybridized and hybridized atoms. LO 29 Using VBT draw and show orientation of the sigma and pi overlaps for a chemical species. LO 30 Name hybridized orbitals and orbital overlaps according to VBT.	Chapter 6.3 Chapter 8.1 Chapter 8.2 Chapter 8.3 Chapter 20.4	31, 39, 41(a,b,d), 42, 43 1, 3-8 9, 13-22 23-27(no e), 29-31 55, 57, 61 & 63

Course aims and objectives:

COLLECTIONS OF CHEMICAL SPECIES • Use the charge distribution in a chemical species to visualize collections of chemical species and help explain physical and chemical changes.

What you will understand by the end of the course…	What you will be able to do by the end of the course…	Textbook References	Suggested Practice Questions
INTERMOLECULAR FORCES Chemical Substances are collections of chemical species that interact with each other	LO 31 Explain the nature of the forces between chemical species LO 32 Explain how the strength of intermolecular interactions relates to the phase of a chemical species. LO 33 Identify and differentiate the types of forces that exist within pure samples and mixtures.	Chapter 10.1	1, 3, 5, 7, 21
PROPERTIES & REACTIVITY The physical properties and chemical reactivity of substances depend on the interactions between chemical species.	LO 34 Understand the difference between a physical and chemical change. LO 35 Use intermolecular interactions to rationalize physical and chemical changes.	Chapter 10.1 Chapter 10.2	9-19 23-25

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 online assignments will cumulatively assess ALL understandings covered prior to when they run. 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 submit (as doc pdf or image files) to D2L, and graded quizzes in D2L.

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 from the textbook, class homework or past examinations are 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:

- There are several opportunities for formal feedback on your progress throughout the term (four online assignments, 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

May 2020 **Bolded statements identify important course understandings that will be understood.**

SUN	MON	TUE	WED	THUR	FRI	SAT
					1	2
3	4	5	6 **Course begins** *Zoom meeting entire class* *1 hr 25 min* Welcome! Intro/Q&A about the course, working online successfully, a community building exercise **Visualization is crucial to understanding the structure and bonding of chemical species** By the end of 201 the LO will be: – Identify and/or generate 2D/3D drawings – Utilize molecular and conceptual models – Make appropriate observations – Recognize and identify the static and/or dynamic components of drawings and models	7	8 *Zoom meeting entire class* *1 hr* **Help understanding how to complete assignments, submit work and receive feedback.** **Online homework** used for Practice.	9
10	11 ***MON/TUES*** ***TUTORIAL 1 participation*** *Zoom meeting tutorial groups* *1 hr 15 min* **Every element has a unique arrangement of electrons** LO 1 Generate ground state electron configurations for elements 1-20 using energy diagrams, orbital box diagrams or *spdf* notation and rationalize when to use one type of visualization versus another.	12 **Last day to add drop or swap**	13 *Zoom meeting entire class* *1 hr 25 min* **Some electrons are more reactive than other electrons.** **Bonding between atoms involves the rearrangement of valence electrons** LO 2 Identify and differentiate between core and valence electrons. LO 3 *Rationalize* ionization energy, electron affinity of atoms by considering the energy of the valence e-s (n, related to how far from the nucleus they are) and the pull of the nucleus on these electrons (Z_{eff}). LO 4 Define electronegativity LO 5 Predict and rationalize the type of bonding that occurs between atoms by using electronegativity differences LO 6 Describe covalent and ionic bonding ***WED/THURS*** ***LAB ACTIVITY 1 4%*** *Virtual meeting lab group* *2 hrs*	14	15 *Zoom meeting entire class* *1 hr* Time to catch up or review. ***Assignment 1 5%*** *2 hrs in 24 hr window*	16

May 2020 continued……

SUN	MON	TUE	WED	THUR	FRI	SAT
17	18 *Victoria Day*	19	20 *Zoom meeting entire class* *1 hr 25 min* **Lewis diagrams show the connectivity between atoms resulting from the rearrangement of valence electrons** LO 7 Generate valid Lewis diagrams for a chemical formula or condensed formula and vice versa. LO 8 Recognize when the octet rule is broken. LO 9 Identify atoms with non-zero-formal charges within a Lewis diagram ***WED/THURS*** ***LAB ACTIVITY 2 4%*** *Virtual meeting lab group* *2 hrs*	21	22 ***TUES/FRI*** ***TUTORIAL 2 participation*** *Zoom meeting tutorial groups* **Moved from Mon due to holiday** *1 hr 15 min* **Lewis diagrams show the connectivity between atoms as a result of the rearrangement of valence electrons** LO 10 Analyze Lewis diagrams to determine their validity. LO 11 Determine bond orders within a chemical species and relate them to bond strength and length	23
24	25 ***MON/TUES*** ***TUTORIAL 3 participation*** *Zoom meeting tutorial groups* *1 hr 15 min* **Some species may display resonance** LO 13 Generate, Identify and rank the stability of valid resonance structures. LO 14 Distinguish equivalent from non-equivalent resonance structures. LO 15 Use curly arrows to interconvert resonance structures. LO 16 Generate and identify a valid resonance hybrid for a set of resonance structures.	26	27 *Zoom meeting entire class* *1 hr 25 min* **Valence Shell Electron Pair Repulsion (VSEPR) structures show the spatial arrangement of atoms within chemical species.** LO 17 Build VSEPR diagrams from valid Lewis diagrams or resonance hybrids and vice versa LO 18 Build Line drawings from valid VSEPR diagrams and vice versa LO 19 Assign electron-pair geometry and molecular shapes to atoms bonded to two three four five or six other atoms. LO 20 Assign approximate bond angles LO 21 Recognize variations in orientation of VSEPR diagrams for the same geometries/shapes ***WED/THURS*** ***LAB ACTIVITY 3 4%*** *Zoom meeting lab group* *2 hrs*	28	29 *Zoom meeting entire class* *1 hr* Time to catch up or review. ***Assignment 2 15%*** *2 hrs in 24 hr window*	30

June 2020

SUN	MON	TUE	WED	THUR	FRI	SAT
31	**1** ***MON/TUES*** ***TUTORIAL 4 participation*** *Zoom meeting tutorial groups* *1 hr 15 min* **Practice with VSEPR** **The spatial arrangement of atoms determines the charge distribution of a chemical species** LO 22 Distinguish between bond polarities and molecular polarity LO 23 Determine the overall molecular polarity of a chemical species. LO 24 Identify polar and non-polar molecules.	2	3 *Zoom meeting entire class* *1 hr 25 min* **Valence Bond (VB) and Molecular Orbital (MO) Theories explain the spatial arrangement of bonds.** LO 25 Describe what an orbital is. LO 26 Draw the boundary diagrams for s and p-type orbitals. LO 27 Contrast VBT and MOT. LO 28 Using VBT draw the energy diagrams for un-hybridized and hybridized atoms. LO 29 Using VBT draw and show orientation of the sigma and pi overlaps for a chemical species. LO 30 Name hybridized orbitals and orbital overlaps according to VBT. ***WED/THURS*** ***LAB ACTIVITY 4 4%*** *Zoom meeting lab group* *2 hrs*	4	5 *Zoom meeting entire class* *1 hr* Time to catch up or review. ***Assignment 3 20%*** *2 hrs in 24 hr window*	6
7	8 ***MON/TUES*** ***TUTORIAL 5 participation*** *Zoom meeting tutorial groups* *1 hr 15 min* **Practice with Valence Bond theory.** LO's 25-28	9	10 *Zoom meeting entire class* *1 hr 25 min* **Chemical Substances are collections of chemical species that interact with each other.** LO 31 Explain the nature of the forces between chemical species LO 32 Explain how the strength of intermolecular interactions relates to the phase of a chemical species. LO 33 Identify and differentiate the types of forces that exist within pure samples and mixtures. ***WED/THURS*** ***LAB ACTIVITY 5 4%*** *Zoom meeting lab group* *2 hr*	11	12 *Zoom meeting entire class* *1 hr* Time to catch up or review. ***Assignment 4 20%*** *2 hrs in 24 hr window*	13

June 2020 continued……..

SUN	MON	TUE	WED	THUR	FRI	SAT
14	15	16	17 **Lectures end** **Last day to withdraw** *Zoom meeting entire class free form groups* *1 hr 25 min* **Focused review of course concepts.** **The physical properties and chemical reactivity of substances depend on the interactions between chemical species.** LO 34 Understand the difference between a physical and a chemical change. LO 35 Use intermolecular interactions to rationalize physical and chemical changes.	18	19 **Exams begin** ***Final Assignment 20%*** *3 hrs in 24 hr window*	20
21	22	23 **Exams end**	24	25	26	27
28	29	30				