Instructor: Dr. Amy Toole  
Email: amy.toole@utoledo.edu  
Office Hours: M 11:30-1:30; T 3:00-4:00; W 11:30-1:30 & 4:00-5:00  
Also by appointment. I like visitors!  
Office Location: BO2086G  
Office Phone: 419-530-1503  
Term: Fall 2018  
Lecture Location: RH1520  
Lecture Sections/Day/Time:  
L37, L90/MWF/ 2:30pm – 3:25pm

Recitation

<table>
<thead>
<tr>
<th>Section</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
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<tr>
<td>38</td>
<td>Tuesdays</td>
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<tr>
<td>39</td>
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<tr>
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<td>47</td>
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<td>94</td>
<td>Tuesdays</td>
<td>02:30 pm-03:25 pm</td>
<td>BO 2049</td>
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</table>

Required Materials:  
- An ALEKS access code: https://www.aleks.com/. ALEKS is an online learning/homework system. When prompted for your class code enter: EVXRQ-PYK6N  
- A Turning Point subscription: https://www.turningtechnologies.com/student/. Turning Point is a class response system. You have the option of purchasing a “clicker” with your subscription or using a personal mobile device (e.g., phone). You also have the option of purchasing your subscription for 1 term, 1 year or 5 years. Among other courses at UT that use the Turning Point system are CHEM 1240 some biology and some physics courses.

Optional Materials (the first two are part of the package sold by the UT Bookstore):  
- Study Guide for Chemistry, 7th Ed, 2016, by Zubricky for McMurry/Fay/Robinson, Pearson. There will not be any assignments from this book, but you may find it helpful.  
- A non-programmable calculator. Only non-programmable calculators are allowed when you take exams in this course.

COURSE/CATALOG DESCRIPTION  
An introduction to atomic structure, chemical bonding, kinetic-molecular theory, energy relationships and structural concepts. This sequence is for students who major in science, engineering or other fields which require chemistry as a prerequisite subject. Three hours lecture and one hour discussion per week.

COURSE OVERVIEW  
CHEM 1230 General Chemistry I and CHEM 1240 General Chemistry II are the lecture courses in the general chemistry sequence. The parallel lab courses are CHEM 1280 and CHEM 1290, which you may be taking with the lecture. General Chemistry is appropriate for students who are majoring in the natural sciences, science education, pharmacy, engineering and some allied health fields. Chemistry is sometimes referred to as a “central science” because the
General Chemistry I – Syllabus

Chemistry 1230-Day Lecture University of Toledo Fall, 2018

application of chemical principles is key to understanding many other sciences. In CHEM 1230 you will study the atomic level structure of matter and how this structure determines the physical properties and reactions of substances. You will become familiar with the language and symbolism of chemistry as well as sharpen your critical thinking and problem-solving abilities.

**COURSE PREREQUISITES AND CO-REQUISITES:**

Your success in CHEM 1230 is important to us, therefore we require that you meet one of these course prerequisites:

1. A score of 50% or higher on the ALEKS chemistry placement exam (earned on the initial assessment or after learning in ALEKS and a subsequent assessment), OR
2. A grade of C or above in CHEM 1090.

If you do not meet either of the above criteria, you must withdraw from CHEM 1230 and register for CHEM 1090.

If your ALEKS initial assessment is below 50% you are required to take CHEM 1200 with CHEM 1230.

**TEACHING/LEARNING STRATEGIES**

Research has shown that learning occurs when the learner is actively involved in “doing” rather than just listening or watching. Practice and repetition are also key to learning. With these ideas in mind the following are used to facilitate learning in this course.

**Lecture sessions:** Attendance is required and you are expected to arrive on time. You are responsible for all material, experiments, and problems covered in class. You will be actively involved in the sessions by taking notes on outlines, answering questions posed through a classroom response system (Turning Point), and working through problems and calculations with guidance from the instructor.

**Textbook:** You should read relevant textbook sections before the lecture sessions so you are familiar with concepts on which we will build in class.

**Recitation sessions:** Attendance is required and you are expected to arrive on time. Weekly recitation sessions provide an opportunity to ask questions and solve problems with a smaller group of students and a teaching assistant (TA). Problems from the end of chapters (EOC) in the textbook will be assigned in advance of the recitation session and you are expected to attend with your proposed solutions to all problems. Credit will be given for all complete attempts even if final answers are not correct. During recitation you will work further toward correct solutions. Below is an overview of EOC problems which will be assigned during the semester. Expect weekly announcements regarding the specific subset due at recitation.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>OVERVIEW: End of Chapter (EOC) Problems from the Textbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27, 35, 39, 47, 49, 51, 61, 63, 71, 75, 81, 83, 95, 101, 103</td>
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<tr>
<td>2</td>
<td>37, 39, 43, 45, 59, 73, 87, 91, 99, 101, 103, 109, 115, 119, 125, 129, 137, 139, 145, 151</td>
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<td>3</td>
<td>29, 31, 35, 37, 43, 49, 51, 57, 61, 67, 73, 75, 77, 83, 85, 87, 101, 105</td>
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<tr>
<td>4</td>
<td>39, 41, 43, 45, 49, 53, 57, 69, 71, 75, 81, 89, 103, 105, 111, 125, 127, 141</td>
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<tr>
<td>5</td>
<td>25, 27, 35, 37, 39, 45, 51, 61, 69, 71, 75, 77, 81, 95, 107, 109, 113, 123</td>
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<td>7</td>
<td>29, 43, 45, 49, 53, 61, 65, 67, 73, 75, 79, 81, 85, 89, 101</td>
</tr>
<tr>
<td>8</td>
<td>39, 43, 45, 47, 49, 53, 59, 63, 65, 67, 73, 77, 81, 83, 87, 91, 93, 95</td>
</tr>
<tr>
<td>9</td>
<td>31, 33, 35, 37, 39, 45, 57, 65, 67, 79, 83, 87, 93, 99, 107, 117, 125, 129, 137</td>
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<tr>
<td>10</td>
<td>29, 31, 37, 39, 53, 55, 61, 69, 75, 83, 85, 101, 107, 113, 117, 127, 131, 135, 137</td>
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<tr>
<td>19</td>
<td>27, 29, 33, 39, 47, 53, 69, 77, 93, 105</td>
</tr>
<tr>
<td>22</td>
<td>37, 44, 47, 56, 59, 61, 67, 83, 99</td>
</tr>
</tbody>
</table>

**ALEKS learning:** ALEKS is an online learning/homework platform that supplements other aspects of the course. Assignments in ALEKS will be given weekly but because ALEKS provides extensive explanations, it is possible to work ahead. In fact, you are encouraged to use ALEKS assignments as an introduction to concepts we will cover during lecture and recitation sessions. You should definitely complete ALEKS problems before the more challenging EOC.
problems on a topic. Note also that because ALEKS is just one of several learning tools we use in the course, it does not completely cover all topics.

TECHNOLOGY REQUIREMENTS
Students need to have access to a properly functioning computer throughout the semester to access Blackboard (https://blackboard.utdl.edu/webapps/login/) and ALEKS (https://www.aleks.com/). Student computers need to be capable of running the latest versions of plug-ins, recent software and have the necessary tools to be kept free of viruses and spyware. Updated software is available from UTs Online Learning Download center (https://www.utoledo.edu/dl/main/downloads.html).

Students are also required to have a Turning Point account and bring a wireless device (phone, computer, tablet) or “clicker” to all lecture classes.

UNIVERSITY POLICIES
The University is an equal opportunity educational institution. Please read The University’s Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.

ACADEMIC ACCOMMODATIONS
The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations/adjustments in this course please contact the Student Disability Services Office.

ACADEMIC POLICIES
Taking Exams: You must show a photo identification card at all exams. You may use a non-programmable calculator, but you will not be permitted to use a programmable calculator or phone.

Exam Conflicts: If you cannot take an exam at the scheduled time due to an irresolvable conflict with a major University related responsibility you must provide written documentation to verify the conflict before the exam date and obtain instructor approval before the exam. This situation may occur for students on official university business. If the documentation is approved, you will be given an opportunity to take the exam at an arranged time before the scheduled test date.

Midterm Exam Absence: Make-up exams will not be given for any circumstance. If you unexpectedly miss a midterm exam due to illness, car accident or similar extreme circumstance you should inform the instructor of your difficulty as soon as possible. The problem must be documented by a physician’s note, an accident report, etc. An email to your instructor and a telephone call within 24 hours is expected. You will also be required to complete an Absence Report Form (obtained from the chemistry office, BO 2022). Documentation supporting your excuse must be attached to the form. If your excuse is acceptable, your final course grade will be computed with the score on the missed exam equal to the average of the other midterm exams. In all other circumstances a missed exam will result in a grade of 0.

Final Exam Absence: The final exam cannot be excused.

Academic Dishonesty: You are urged to refer to the University’s policy on Academic Dishonesty in the university catalogue. Violation of this policy can result in a course grade of F with additional university sanctions possible. You are also required to read and agree to a course specific Academic Honesty Statement which has been posted on Blackboard. Both the University and course specific Academic Honesty Statement will be strictly enforced.

COMMUNICATION GUIDELINES
You are expected to check your UT email account and Blackboard frequently for important course information. As your instructor, I am here to help, and will do my best to respond to email within 24 to 48 hours. My office hours are listed at the beginning of the syllabus and you are always welcome to make an appointment outside of those hours.
General Chemistry I – Syllabus
Chemistry 1230-Day Lecture
University of Toledo
Fall, 2018

GRADING

**Course Points:** The following is the distribution of possible points in the course.

<table>
<thead>
<tr>
<th>Course Aspect</th>
<th>Points</th>
<th>Percentage of Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-term exams (100 points each)</td>
<td>300</td>
<td>46.2%</td>
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<tr>
<td>Final exam</td>
<td>150</td>
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</tr>
<tr>
<td>Participation (Turning Point, recitation attendance, EOC problems,</td>
<td>100</td>
<td>15.4%</td>
</tr>
<tr>
<td>additional assignments at instructor’s discretion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALEKS assignments</td>
<td>100</td>
<td>15.4%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>650</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** You will have the opportunity to earn more than 100 points for “Participation”, however, no more than the maximum of 100 points will be counted for any student.

**Letter Grades:** These are the minimum percentages of total points needed to receive the indicated letter grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum Percentage</th>
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</thead>
<tbody>
<tr>
<td>A</td>
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</tr>
<tr>
<td>A-</td>
<td>85%</td>
</tr>
<tr>
<td>B+</td>
<td>81%</td>
</tr>
<tr>
<td>B</td>
<td>77%</td>
</tr>
<tr>
<td>B-</td>
<td>73%</td>
</tr>
<tr>
<td>C+</td>
<td>69%</td>
</tr>
<tr>
<td>C</td>
<td>64%</td>
</tr>
<tr>
<td>C-</td>
<td>60%</td>
</tr>
<tr>
<td>D+</td>
<td>57%</td>
</tr>
<tr>
<td>D</td>
<td>53%</td>
</tr>
<tr>
<td>D-</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Drop, Withdrawal and Incomplete Grades:** *Dropped* courses do not appear on your transcript. The deadline for dropping is **September 10th**. You may *withdraw* from the course and receive a grade of **W**. The deadline for withdrawal is **November 2nd**. **W**’s do not affect your GPA. A course grade of Incomplete is given only to those who have completed all but a small percentage of course requirements for an acceptable reason. The Incomplete must be removed before you take CHEM 1240.

Course registration changes and attendance may affect your financial aid. Throughout the term instructors report student attendance, so you will want to be sure that you are in attendance for all classes. You will remain enrolled in the class independent of attendance reports, unless you take the action of dropping or withdrawing.

**Note:** If you drop or withdraw from CHEM 1230, you are to drop/withdraw from the lab course CHEM 1280 because you need to know the lecture material to be in lab.

**STUDENT SUPPORT**

**Course scheduling assistance:** Chemistry Department Secretary, Ms. Samples, is in Room BO 2022, telephone 419-530-2698. She takes care of all scheduling changes.

**Chemistry Help Center:** Located in room BO 2043, the Center is generally open all day Monday through Friday & evenings Monday through Thursday. TAs are available here: a schedule of their hours will be posted early in the term. No appointment is necessary and all TAs can help with General Chemistry.

**UT Tutoring:** Tutoring is available for a variety of subjects through the **Learning Enhancement Center** located in the Carlson Library.

**CHEM 1200 – Problem Solving in General Chemistry:** CHEM 1200 is a supplemental course to CHEM 1230 and we encourage you to add it to your schedule if it is not there now. It is a workshop-based class designed to help you master the CHEM 1230 material. You will work in small groups under the guidance of an advanced student. It is scheduled for 1 hour 50 minutes on Thursdays or Fridays but some sessions are completed in 90 minutes.
<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Chapter: Topic</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1    | Aug 27 - Aug 31 | 1. Chemical Tools  
2. Atoms, Molecules & Ions  
3. Mass Relationships in Chemical Reactions | Review Chapters 1, 2 on your own. Chapter 3 will be covered in class. |
| 2    | Sept 3 - 7  | 3. Continued   | 9/3 is Labor Day. Classes are cancelled. |
| 3    | Sept 10 – 14 | 4. Reactions in Aqueous Solution   | Last day to Drop via the web is Mon 9/10 |
| 4    | Sept 17 – 21 | 4. Continued  
5. Periodicity & the Electronic Structure of Atoms | Midterm Exam 1, Wed 9/19, Chapters 1, 2, 3, 4 (partial) |
| 5    | Sept 24 – 28 | 5. Continued                       |                                                                      |
| 7    | Oct 8 – 12  | 6. Continued  
7. Covalent Bonding & Electron-Dot Structures | 10/11 – 10/12 is Fall Break. Classes are cancelled. |
| 8    | Oct 15 – 19 | 7. Continued                        |                                                                      |
| 9    | Oct 22 – 26 | 8. Covalent Compounds: Bonding Theories & Molecular Structure                  | Midterm Exam 2, Wed 10/24 Chapters 4 (partial), 5, 6, 7, and review of Exam 1 |
| 10   | Oct 29 – Nov 2 | 8. Continued                         | Last day to Withdraw via the web is Friday 11/2                       |
| 11   | Nov 5 – Nov 9 | 9. Thermochemistry: Chemical Energy                                          |                                                                      |
| 12   | Nov 12 – 16 | 9. Continued                        | 11/12 is Veterans Day. Classes are cancelled                         |
| 13   | Nov 26 – Nov 30 | 10. Continued                     | Midterm Exam 3, Wed 11/28, Chapters 8, 9, 10, and review of Exams 1 and 2 |
| 14   | Dec 3 – Dec 7 | 19. Nuclear Chemistry*  
22. The Main-Group Elements*      | *Material covered (Ch 19, 22) varies by instructor                     |
| Finals Week | Dec 10 – 14 | The Final Exam is comprehensive. A document about the exam will be distributed. | ****** Final Exam ******  
Wednesday, 12/12, 8:00 – 10:00am  
You Must Take The Final At This Time! |

Be Sure That Your Travel & Employment Plans Do Not Conflict With This Schedule.
STUDENT LEARNING OBJECTIVES
Based on the Textbook: Chemistry, McMurry, Fay, Robinson 7e

Chapter 1 Chemical Tools: Experimentation and Measurement
1.2 Differentiate between a qualitative and quantitative measurement.
1.3 Write numbers in scientific notation and use prefixes for multiples of SI units.
1.5&6 Convert between different prefixes used in mass & length measurements
1.7 Convert between common units of temperature measurements.
1.9 Convert between different prefixes used in volume measurements.
1.10 Calculate mass, volume, or density using the formula for density.
1.11 Predict whether a substance will float or sink in another substance based on density.
1.12 Calculate kinetic energy of a moving object.
1.13 Convert between common energy units.
1.16 Report a measurement to the appropriate number of significant figures.
1.17 Report the answer of mathematical calculations to the correct number of significant figures.
1.19 Change a measurement into different units using appropriate conversion factors.

Chapter 2 Atoms, Molecules, and Ions
2.1 Use symbols to represent element names.
2.2 Identify the location of metals, nonmetals, and semimetals on the periodic table.
2.3 Indicate the atomic number, group number, and period number for an element whose position in the periodic table is given.
2.4 Identify groups as main group, transition metal group, or inner transition metal group.
2.7 Determine the mass of the products of a reaction using the law of mass conservation.
2.11 Describe Rutherford’s gold foil experiment and what it contributed to the current model of atomic structure (Figure 2.5).
2.12 Describe the structure and size of the atom (Figure 2.6).
2.13 Calculate the number of atoms in a sample given the size of the atom.
2.14&15 Determine the mass number, atomic number, and number of protons neutrons and electrons from an isotope symbol & write isotope symbols for elements.
2.16 Calculate atomic weight given the fractional abundance and mass of each isotope.
2.17 Convert between grams and numbers of moles or atoms using the molar mass and Avogadro’s number.
2.18 Identify an element given the mass and number of atoms or moles.
2.19 Classify molecular representations of matter as a mixture, pure substance, element, or compound.
2.20 Convert between structural formulas, ball-and-stick models, and chemical formulas.
2.21 Classify bonds as ionic or covalent.
2.22 Determine the number of electrons and protons from chemical symbol and charge.
2.23 Match the molecular representation of an ionic compound with its chemical formula.
2.24&25 Convert between name and formula for ionic compounds.
2.26 Convert between name and formula for binary molecular compounds.

Chapter 3 Mass Relationships in Chemical Reactions
3.1 Visualize bonds broken and formed in a chemical reaction and relate numbers of molecules or atoms to the balanced reaction
3.2 Balance a chemical reaction given the formulas of reactants and products.
3.3 Calculate formula weight, molecular weight, and molar mass given a chemical formula or structure.
3.4 Interconvert between mass, moles, and molecules/atoms of a substance.
3.5 Relate the amount (moles or mass) of reactants and products in a balanced equation using stoichiometry.
3.6 Calculate percent yield given amounts of reactants and products.
3.7 Visualize the relative amounts of atoms or molecules in the reactants and products of a balanced reaction
3.8 Determine which reactant is limiting and calculate the theoretical yield of the product and the amount of excess reactant.
3.9 Calculate percent yield when one reactant is limiting.
3.10 Calculate the percent composition given a chemical formula or structure.
3.11 Determine the empirical and molecular formula given the mass percent composition and molecular weight of a
3.12 Determine the empirical and molecular formula given combustion analysis data and molecular weight.
3.13 Determine the molecular weight of a substance given a mass spectrum. Determine empirical and molecular formula using both mass spectral and combustion analysis data.
3.14 Identify a compound using molecular weight measured with a high mass accuracy mass spectrometer.

Chapter 4 Reactions In Aqueous Solution
4.1 Calculate the molarity of a solution given the mass of solute and total volume.
4.2 Calculate the amount of solute in a given volume of a solution with a known molarity.
4.3 Describe the proper technique for preparing solutions of known molarity.
4.4 Calculate the concentration of a solution after dilution.
4.5 Describe the proper technique for diluting solutions.
4.6 Classify a substance as a strong, weak, or nonelectrolyte.
4.7 Calculate the concentration of ions in a strong electrolyte solution.
4.8 Classify a reaction as a precipitation, acid–base neutralization, or oxidation–reduction (redox) reaction.
4.9 Write an ionic and net ionic equation and identify spectator ions given the molecular equation.
4.10 Use the solubility guidelines in Table 4.2 to predict the solubility of an ionic compound in water.
4.11 Predict whether a precipitation reaction will occur and write the ionic and net ionic equations.
4.12 Convert between name and formula for an acid.
4.13 Classify acids as strong or weak based on the molecular picture of dissociation.
4.14 Write the ionic equation and net ionic equation for an acid-base neutralization reaction.
4.15 Convert between moles and volume using molarity in stoichiometry calculations.
4.16 Determine the concentration of a solution using titration data.
4.17 Visualize the substances present in solution during a titration procedure.
4.18 Assign oxidation numbers to atoms in a compound.
4.19 Identify redox reactions, oxidizing agents, and reducing agents.
4.20 Use the location of elements in the periodic table & activity series to predict if a redox reaction will occur.
4.21 Develop an activity series and predict if a redox reaction will occur based on experimental data provided.
4.22 Use a redox titration to determine the concentration of an oxidizing or reducing agent in solution.

Chapter 5 Periodicity and Electronic Structure of the Atom
5.1 Label the wavelength, frequency and amplitude in an electromagnetic wave and understand their meaning.
5.2 Interconvert between wavelength and frequency of electromagnetic radiation.
5.3 Calculate the energy of electromagnetic radiation in units of J/photon or kJ/mol, when given the frequency or wavelength.
5.4 Describe the photoelectric effect and explain how it supports the theory of particlelike properties of light.
5.5 Calculate the frequency or wavelength of radiation needed to produce the photoelectric effect given the work function of a metal.
5.6 Compare the wavelength and frequency of different electron transitions in the Bohr model of the atom.
5.7 Relate wavelengths calculated using the Balmer-Rydberg equation to energy levels in the Bohr model of the atom.
5.8 Calculate the wavelength of a moving object using the de Broglie equation.
5.9 Explain why the wavelength of macroscopic objects is not observed.
5.10 Calculate the uncertainty in the position of moving object if the velocity is known.
5.11 Identify and write valid sets of quantum numbers that describe electrons in different types of orbitals.
5.12 Identify an orbital based on its shape and describe it using a set of quantum numbers.
5.13 Visualize the nodal planes in different types of orbitals and different shells.
5.14 Assign a set four quantum numbers for electrons in an atom.
5.15 Explain how electron shielding gives the order of subshells from lowest to highest in energy.
5.16 Predict the order of filling of subshells based upon energy.
5.17 Assign electron configurations to atoms in their ground state.
5.18 Draw orbital filling diagrams for the ground state of an atom & determine the # of unpaired electrons.
5.19 Identify atoms from orbital filling diagrams or electron configurations.
5.20 Explain the periodic trend in atomic radii.
5.21 Predict the relative size of atoms based upon their position in the periodic table.

Chapter 6 Ionic Compounds: Periodic Trends and Bonding Theory
6.1 Write ground-state electron configurations for main group and transition metal ions.
6.2 Determine the number of unpaired electrons in a transition metal ion.
6.3 Predict the relative size of anions, cations, and atoms.
6.4 Predict the relative size of isoelectronic ions.
6.5 Order elements from lowest to highest ionization energy.
6.6 Explain the periodic trend in ionization energy.
6.7 Compare successive ionization energies for different elements.
6.8 Identify elements based on values of successive ionization energies.
6.9 Compare the value of electron affinity for different elements.
6.10 Explain the periodic trend in electron affinity.
6.11 Use the octet rule to predict charges on main group ions, electron configurations of main group ions, and formulas for ionic compounds.
6.12 Visualize ionic compounds on the molecular level.
6.13 Draw a Born-Haber cycle and calculate the energy change that occurs when an ionic compound is formed from its elements.
6.14 Use the Born-Haber cycle to solve for the energy change associated with one of the steps.
6.15 Predict the relative magnitude of lattice energy given the formula or molecular representation of an ionic compound.

Chapter 7 Covalent Bonding and Electron-Dot Structures
7.1 Describe the difference between an ionic and covalent bond.
7.2 Describe changes in energy that occur as two nuclei approach to form a covalent bond.
7.3 Name a covalent compound given the chemical formula.
7.4 Predict trends in bond length and bond dissociation energy based on bond order and atomic size.
7.5 Rank elements by increasing value of electronegativity.
7.6 Classify bonds as nonpolar covalent, polar covalent, or ionic.
7.7 Visualize regions of high and low electron density in a polar covalent bond.
7.8 Predict trends in bond dissociation energy based upon both atomic size and polarity of the bond.
7.9 Explain the different physical properties of NaCl & HCl based upon the ionic & covalent bonding models.
7.10 Draw an electron-dot structure by using valence electrons to give all atoms (except H) an octet
7.11 Use the five-step procedure for drawing electron-dot structures for all molecules including those with, expanded octets, and those containing multiple bonds
7.12 Draw electron-dot structures for free radicals.
7.13 Draw electron-dot structures for molecules with more than one central atom.
7.14 Draw a complete electron-dot structure given only the connections of atoms.
7.15 Draw resonance structures and use curved arrows to depict how one structure can be converted to another.
7.16 Calculate formal charge on atoms in an electron-dot structure.
7.17 Use formal charge to evaluate the contribution of different resonance structures to the resonance hybrid.

Chapter 8 Covalent Compounds: Bonding Theories and Molecular Structure
8.1 Use the VSEPR model to predict geometry from the total number of charge clouds and lone pairs of electrons around an atom.
8.2&3 Use the VSEPR model to predict bond angles and overall shape of a molecule or ion with one or more central atoms.
8.4 Describe the difference between a sigma and pi bond.
8.5 Determine the type of hybrid orbitals based upon the number of charge clouds around an atom.
8.6 Write an electron-dot structure for a molecule and determine hybridization and bond angles on non-terminal atoms.
8.7 Identify which orbitals overlap to form sigma and pi bonds in molecules.
8.8 Predict whether a given molecule has a dipole moment and draw its direction.
8.9 Interpret electrostatic potential maps of molecules.
8.10 Calculate the percent ionic character in a bond.
8.11 Identify the types of intermolecular forces experienced by a molecule.
8.12 Relate the strength of intermolecular forces to physical properties such as melting point and boiling point.
8.13 Sketch the hydrogen bonding that occurs between two molecules.
8.14 Interpret the molecular orbital diagram for a first row diatomic molecule or ion.
8.15 Interpret the molecular orbital diagram for a second row diatomic molecule or ion. Calculate the bond order and predict magnetic properties.
8.16 Draw orbital overlap diagrams for molecules and describe the use of both valence bond theory and molecular orbital theory.

Chapter 9 Thermochemistry: Chemical Energy
9.1 Calculate the kinetic energy of an object in motion.
9.2 Convert between common units for energy.
9.3 Identify state functions.
9.4 Identify the sign of heat and work.
9.5 Calculate $PV$ work.
9.6 Calculate the internal energy change ($\Delta E$) for a reaction.
9.7 Given a thermochemical equation and the amount of reactant or product, calculate the amount of heat transferred.
9.8 Classify endo- and exothermic reactions.
9.9 Calculate heat capacities, temperature changes, or heat transfer using equation for heat capacity ($C$) specific heat ($c$), or molar heat capacity ($C_m$).
9.10 Calculate enthalpy changes in a calorimetry experiment.
9.11 Use Hess’s Law to find $\Delta H$ for an overall reaction, given reaction steps and their $\Delta H$ values.
9.12 Identify standard states of elements.
9.13 Write standard enthalpy of formation reactions ($\Delta H^\circ$) for compounds from their elements.
9.14 Use values of ($\Delta H^\circ$) for elements and compounds to calculate $\Delta H^\circ$ for a reaction.
9.15 Use bond dissociation energies to estimate $\Delta H^\circ$ for a reaction.
9.16 Calculate $\Delta H^\circ$, for various fuels using thermochemical principles such as Hess’s Law, calorimetry, or bond dissociation enthalpies.
9.17 Predict the sign of the entropy change ($\Delta S$) given the chemical equation or a molecular diagram.
9.18 Using the relationship between Gibbs free energy and spontaneity, predict the sign of $\Delta G, \Delta H, \Delta S$.
9.19 Use the Gibbs free energy equation to calculate an equilibrium temperature.

Chapter 10 Gases: Their Properties and Behavior
10.1 Convert between different units of pressure.
10.2 Describe how a barometer and manometer measure pressure.
10.3 Use the individual gas laws to calculate pressure, volume, molar amount, or temperature for a gas sample when conditions change.
10.4 Use the ideal gas law to calculate pressure, volume, molar amount, or temperature for a gas sample.
10.5 Calculate volumes of gases in chemical reactions.
10.6 Calculate the density or molar mass of a gas using the formula for gas density.
10.7 Calculate the partial pressure, mole fraction, or amount of each gas in a mixture.
10.8 Use the assumptions of kinetic–molecular theory to predict gas behavior.
10.9 Calculate the average molecular speed of a gas particle at a given temperature.
10.10 Visualize the processes of effusion and diffusion.
10.11 Use Graham’s Law to estimate relative rates of diffusion for two gases.
10.12 Understand the conditions when gases deviate the most from ideal behavior.
10.13 Use the van der Waals equation to calculate the properties of real gases.
10.14 Convert between different units used to express the concentration of pollutants.
10.15 Use the gas laws, Dalton’s Law, and stoichiometry to calculate amounts of pollutant gases in the atmosphere.
10.16 Identify the components and causes of photochemical smog.
10.17 Explain the principle of the greenhouse effect.
10.18 Describe the trends in greenhouse gas concentrations over time and predicted effects of climate change.
General Chemistry I – Syllabus
Chemistry 1230-Day Lecture University of Toledo Fall, 2018

Chapter 19 Nuclear Chemistry*
19.1 Give the different kinds of radioactive decay and the results of each.
19.2 Write balanced nuclear reactions.
19.3 Predict the type of radioactive decay for a given isotope.
19.5 Relate half-life and decay constant.
19.6 Calculate the amount of radioactive isotope remaining after a given amount of time.
19.7 Relate decay rates to decay constant, half-life, or amount remaining.
19.8 Calculate the mass defect and binding energy of a nucleus.
19.10 Calculate the mass defect of a chemical reaction.
19.11 Identify key aspects of fission and fusion reactions and their role in nuclear power and weapons.
19.13 Write balanced equations for nuclear transmutation reactions.
19.15 Calculate the age of an object using radioisotopic dating.

Chapter 22: The Main-Group Elements*
22.1 Use the periodic table to predict the properties of the main-group elements and their compounds.
22.2 Account for differences in the structure and properties of second-row elements and the structure and properties of third- and higher-row elements.
22.3 Describe the preparation of elemental hydrogen.
22.4 Write and balance a chemical equation for the reaction of ionic hydrides with water.
22.5 Classify binary hydrides and describe their bonding and properties.
22.6 Use periodic trends to predict properties of Group 1A and 2A elements.
22.7 Write and balance reactions of alkali and alkaline-earth metals with halogens, oxygen, and water.
22.8 Write electrode reactions & perform calculations in the electrolysis of molten salts to produce alkali & alkaline-earth metals.
22.9 Explain why the properties of boron differ from other 3A elements.
22.10 Describe the structure and bonding in diborane.
22.11 Draw electron-dot structures, predict hybrid orbitals & geometry for molecules & ions in main group compounds.
22.12 Describe the structure and properties of the allotropes of carbon.
22.13 Use the shorthand notation for a silicate anion to represent its structure and interpret the notation to find the formula and charge of a silicate anion.
22.14 Write electron-dot structures and describe the structure, bonding, and properties of molecules and ions in main-group compounds containing N and P.
22.15 Relate compound names, formulas, and oxidation states in compounds.
22.16 Classify the oxide of an element as ionic or covalent, and as acidic, basic, or amphoteric.
22.17 Write reactions of oxides and sulfur compounds.
22.18 Write electron-dot structures and describe the structure, bonding, and properties of molecules in main-group compounds containing O and S.
22.19 Write balanced equations for the formation of halogens and reactions of their compounds.
22.20 Relate compound names, formulas, and oxidation states in compounds.
22.21 Predict the relative acid strengths of oxoacids.

*Material covered (Ch 19, 22) varies by instructor