CHEM 121 Foundations of General Chemistry w/ Lab **4 credits**

November, 2023

Prerequisites: High school chemistry

Instructor: Heather Dorman, PhD
Rodney Austin, Ph.D.
David Gallaher, Ph.D.
Kathy Austin, MEd
H Elaine Frey, MHA
Craig Kozminski, MAT
Hannah McGuire, MAT
Jessica Schiren, MS, MAT

Contact Information: Faculty may be contacted through the Canvas messaging system

Additional Information: www.portagelearning.edu*

Course meeting times: CHEM 121 is offered continuously

Course Description: A single-semester, comprehensive exploration of the fundamental laws, theories and mathematical concepts of inorganic, organic and biological chemistry designed to contain comprehensive information needed for health professions study. The laboratory component of this course is delivered using virtual labs and interactive simulations with detailed instruction and demonstrations from an experienced chemist.

Course Outcomes: As a result of this course experience a student should be able to:

- Perform basic scientific and measurement calculations.
- Describe the electron structure and chemical periodicity of atoms
- Name and write formulas for common inorganic compounds
- Perform stoichiometric, thermochemical and molarity calculations
- Determine the bonding, geometry and polarity of molecules and use these to explain the physical properties of these molecules
- Balance simple and redox chemical equations
- Understand gases and perform gas law calculations
- Predict the effect of various stresses on chemical equilibria
- Explain acid/base properties and perform pH and titration calculations

* Portage Learning college courses are offered by Geneva College, which is accredited by the Middle States Commission on Higher Education. Portage Learning is included in the College's Department of Professional and Online Graduate Studies; courses are delivered through the Portagelearning.edu platform.

- Describe the structures and properties of simple organic compounds and name or write formulas for these compounds
- Predict and describe the typical reactions of simple organic compounds
- Recognize the structures of carbohydrates, lipids, proteins and nucleic acids and their building-block molecules

*Please see the *Module & Lab Topics* section below for expanded course outcomes.

Lab Outcomes: As a result of this laboratory experience a student should be able to:

- Practice safe procedures in the chemical laboratory
- Perform accurate volume and mass measurement
- Carry out and describe chemical reactions
- Carry out extraction and distillation procedures
- Perform pH measurements
- Carry out acid-base titrations
- Carry out organic and inorganic synthesis
- Perform qualitative and quantitative analyses

The CHEM 121 student learning outcomes are measured:

Directly by: (1) Module application problems (with instructor feedback)
(2) Module exams
(3) Lab notebooks and lab applications
(4) Cumulative final exam

Indirectly by an end of course student-completed evaluation survey

Course Delivery: This course is asynchronously delivered online and is composed of 10-15 hours of module assignments, 20-25 hours of video lectures, 10-15 hours of secure online exams, 10-15 hours of demonstration labs, 5-10 hours of lab notebook maintenance, 10-15 hours of lab applications.

Required Computer Accessories: It is recommended that students use a desktop or laptop computer, PC or Mac, when taking the course. Some tablet computers are potentially compatible with the course, but not all features are available for all tablet computers. The latest full version of Google Chrome, Firefox, Edge, or Safari browser is required for the optimal operation of the Canvas Learning Management System. In addition, this course will use the Respondus Lockdown Browser for exams; a strong internet connection is needed. You are also **required to use LockDown Browser with a webcam**, which will record you during an online, nonproctored exam. (The webcam feature is sometimes referred to as “Respondus Monitor.”) **Your computer must have a functioning webcam and microphone. Additionally, a photo ID that includes your picture and full name is required. Please note, Chromebooks and tablets (other than iPad) are not compatible on exams using the Lockdown Browser.** Instructions on downloading and installing this browser will be

given at the start of the course. We highly recommend using a high-speed Internet connection to view the video lectures and labs. You may experience significant difficulties viewing the videos using a dial-up connection.

For more information on basic system and browser requirements, please reference the following:
Canvas browser and system requirements: https://community.canvaslms.com/t5/Canvas-Basics-Guide/What-are-the-browser-and-computer-requirements-for-Canvas/ta-p/66
Respondus Requirements: https://web.respondus.com/he/lockdownbrowser/resources/
Respondus Monitor Requirements: https://web.respondus.com/he/monitor/resources/

Course Progression: It is the policy for all Portage Learning courses that only one (module lecture/final) exam is to be completed within a 48-hour period. Research on the best practices in learning indicates that time is needed to process material for optimal learning. This means that once an exam has been completed, the next exam may not be opened or taken until 48 hours after the submission of the previous module exam [this includes the final exam]. This allows for instructor feedback/class expectations as the student moves through the material. Instructors, like the College, are not available during the weekend; grading, therefore, is M-F and may take up to 72 hours during these days. Also, it is the policy of Portage Learning to support a minimum of 28 days to complete a course; this is not a negotiable time period. Please plan your time accordingly.

Note: Professors reserve the right to reset any exam taken in violation of these guidelines.

Required readings, lectures and assignments: Portage courses do not use paper textbooks. Students are required to read the online lesson modules written by the course author which contain the standard information covered in a typical course. Please note the exam questions are based upon the readings. Video lectures which support each lesson module subject should be viewed as many times as is necessary to fully understand the material.

We do not support the use of outside resources to study, except for the ones listed in the syllabus under "Suggested External References". If you have questions about the material or would like further explanation of the concepts, please contact your instructor.

Module Problem Sets: The module problem sets within the modules are required and a part of your final grade. They will be reviewed for completeness (not correctness) by the instructor. You must show your work in order to receive full credit. **Be sure to answer all of the problems, being careful to answer the questions in your own words at all times since this is an important part of adequate preparation for the exams.** After you submit the problem set, compare your answers to the solutions provided. If your answers do not match those at the end, attempt to figure out why there is a difference. If you have any questions, please contact the instructor via the Canvas messaging system (see Inbox icon).

Requirements for Lab:

For the laboratory portion of the course, students will observe an experienced lab instructor. **It is the responsibility of the student to view each lab video in its entirety** and only mark the lab as “done” when it is completed. Do not open all the labs at once; otherwise, they may be reset at the discretion of the instructor.

Students are required to keep a lab notebook while watching the videos and submit their signed and dated notebook prior to the related lab exam. The lab notebook is a graded component of the course. A lab notebook template and explanation and expectations are provided under "Lab Overview". The lab notebook and explanation and expectations can be used as a resource to the student while completing their lab application assignment(s). Please note that the use of outside material (i.e. the internet, textbooks, articles, etc.) is not permitted while completing their lab application assignment(s). A recommended lab schedule can be found under "Lab Overview"; the student should follow this schedule to meet course objectives.

Additional Tools: There are two different calculators that will be provided within the exam. One of the calculators can be found here: https://www.desmos.com/scientific. If you plan on using this calculator for the exams it would be wise to practice using it for both the practice problems and module problem sets. There is also a calculator that is built into LockDown Browser. It can be found in the top left hand corner as a small calculator symbol and only appears during exams. If you have any questions regarding how to input numbers or perform certain calculations, please contact your instructor for assistance before moving forward in the course. You are also welcome to use a personal calculator (non-cell phone) if you would like. Keep in mind that you do not need to purchase an expensive calculator as the features you will need are available on basic scientific calculators with a cost of less than $20.

Academic Integrity is a serious matter. In the educational context, any dishonesty violates freedom and trust, which are essential for effective learning. Dishonesty limits a student's ability to reach his or her potential. Portage places a high value on honest independent work. We depend on the student's desire to succeed in the program he or she is entering. It is in a student's own best interests not to cheat on an exam or put their work into question, as this would compromise the student's preparation for future work. It is the student’s responsibility to review the **Student Handbook** and all policies related to academic integrity. If clarification is necessary, the student should reach out to their instructor for further explanation **before** initiating module one.

Modules and Labs

Module 1: This module introduces the science of chemistry by examining its fundamental terminology and measurement system. The metric system is explained, compared to the English customary system and applied. Matter is classified and atomic theory is introduced. The Periodic Table is presented as a foundation for discussion of the elements and their application to the naming of chemical compounds and writing of their formulas.

Module 2: Chemical reactions are considered in this module including balancing and listing of common types and redox equations. Percent composition and determination of empirical and molecular formulas are presented. The mole concept is explained and applied to stoichiometric equation calculations. Molarity solution concentration is also discussed as an application of the mole concept.

Module 3: The module begins with a discussion of the kinetic-molecular theory of gases as an introduction to the presentation of and application of the combined and ideal gas laws and use of these in determination of gas volume stoichiometry. The topic of gases is extended further to include an examination of the law of partial pressures and diffusion and effusion. This module also contains a detailed treatment of atomic structure including determination of electron configuration and orbital diagrams. The wave theory of the electron is presented along with the quantum theory of the atom leading to the determination of quantum numbers and use of this material to predict periodic trends in the atomic properties of ionization energy, electronegativity and atomic size.

Module 4: This module includes a detailed treatment of ionic and covalent intra-molecular bonding and various types of inter-molecular bonding. Lewis structures are discussed and used to determine electron geometry, hybridization and molecular shape. This information is then applied to predict molecular polarity and used to predict physical properties and solubility.

Module 5: This module contains a detailed examination of kinetics including calculation of reaction rate and its use to determine rate constants and reaction order. Radioactive decay is examined as an example of first order reactions. Collision theory is introduced leading to examination of energy of activation, transition state, reaction spontaneity, heat of reaction, catalysis and enzymes. Reversible reactions are examined so as to discuss equilibrium reactions and determination and use of the equilibrium constant and LeChatelier's principle.

Module 6: This module contains an extensive treatment of acid-base chemistry beginning with terminology definitions and a discussion and application of the three most common acid-base theories. Relative acid and base strengths are predicted, and types of reactions of acids and bases are considered. pH is defined and determined. Acid-base titration calculations are carried out and expanded to include titration curves and their use to determine endpoints and indicator choice. Weak acid/weak base equilibria are examined and applied to determine pH and percent ionization and extended to explain the effect of acid-base buffers.

Module 7: This module presents the chemistry of organic compounds beginning with a review of the structure and nomenclature of the four types of hydrocarbons and continuing with structure and nomenclature of nine other common functional group types. The five most common types of organic reactions are listed and discussed. Organic structure determination by spectroscopic analysis is examined including SEM/EDS qualitative elemental analysis, Mass Spectrum

analysis for molecular weight, Infrared (IR) analysis for the presence of certain functional groups and Nuclear Magnetic Resonance (^{1}H-NMR) analysis for H arrangement.

Module 8: This module includes an examination of biochemistry and nuclear chemistry. The structures and functions of each of the four main classes of biochemical materials (carbohydrates, lipids, proteins and nucleic acids) are presented. The nuclear chemistry section begins with an examination of nuclear particles and their involvement in the balancing of the five types of radioactive decay reaction equations or transmutation reaction equations. This section concludes with a treatment of nuclear half-life processes and mass-energy conversion and binding energy calculations.

Lab 1: This lab includes a presentation of safety and equipment aspects of the chemistry laboratory as well as an examination of mass and volume measurement. Each of the common items of lab equipment is presented and discussed. Mass measurement is carried out using the various types of balances commonly used in the lab. Volume is measured using cylinders, pipettes and burettes and the accuracy of these devices is compared.

Lab 2: In this lab, mass and volume measurement are carried out and used to determine the density of many solid and liquids and some materials of biological interest. The determined densities are compared to known values to introduce the concepts of percent error and average deviation.

Lab 3: This lab examines quantitative and qualitative chemical analysis. The quantitative analysis of a metal carbonate is carried out to determine percent CO_2 and used to determine the identity of the metal carbonate. The quantitative analysis of a hydrate is carried out to determine the percent water and used to determine the identity of the metal hydrate. Paper chromatography is performed on an amino acid mixture and used to determine the amino acid components of the artificial sweetener Aspartame. Scanning Electron Microscopy is performed on various materials to determine their qualitative elemental composition and used to determine the identity of two unknown substances.

Lab 4: In this lab, several examples of the six types of chemical reactions are carried out and five types of results are observed during the reactions. The oxidation-reduction of methylene blue indicator is carried out to demonstrate the reversibility of a reaction.

Lab 5: In this lab, a variety of organic compounds are compared as to their water solubility, boiling points determined by distillation and Infrared spectra to determine what types of inter-molecular and intra-molecular bonding might be present in those materials. The types of materials studied are ionic, polar, non-polar, hydrogen-bonding.

Lab 6: In this lab, equilibrium reactions are studied quantitatively by first determining the equilibrium constant for the acid-catalyzed esterification of acetic acid with 1-propanol. Then seven reversible reactions are studied to demonstrate the shifting of these equilibrium reactions according to LeChatelier's principle.

Lab 7: In this lab, six acid-base titrations are carried out for various purposes. (1) The first titration is a weak acid- strong base titration between potassium biphthalate and sodium hydroxide solution for the purpose of standardizing the NaOH. (2) The standard NaOH is then used in another weak acid- strong base titration between vinegar and the NaOH to determine the percent acetic acid in the vinegar. (3) The standard NaOH is then used in a strong acid- strong base titration between a HCl solution and the NaOH to standardize the HCl solution. (4) The standard HCl is then used in a strong acid- weak base titration between household ammonia and the HCl to determine the percent ammonia in the cleaning solution. (5) The standard HCl and standard NaOH are also used in a back-titration procedure between antacid tablets and the HCl to determine the percent $CaCO_3$ in the antacid tablet. Lastly, the standard NaOH is used in a titration of acetic acid by pH meter to construct a titration curve to determine the K_a of acetic acid and demonstrate the suitability of phenolphthalein as an indicator for the titration.

Lab 8: In this lab organic synthesis is demonstrated as three syntheses are carried out from available precursors. Aspirin is synthesized from salicylic acid and the product's structure is confirmed by chemical test, melting point and Infrared spectroscopy. Urea is synthesized from ammonium cyanate and the product's structure is confirmed by melting point and Infrared spectroscopy. Salicylic acid is synthesized from oil of Wintergreen and the product's structure is confirmed by chemical test, melting point and Infrared spectroscopy. In all syntheses, percent yields are determined.

Lab 9: In this lab inorganic synthesis is demonstrated as three syntheses are carried out from available precursors. Alum is synthesized from scrap aluminum foil and the product's structure is confirmed by melting point and Infrared spectroscopy. Calcium carbonate is synthesized by mixing solutions of sodium carbonate and calcium chloride and the product's structure is confirmed by Infrared spectroscopy. Zinc iodide is synthesized by a combination reaction between zinc and iodine and the product's structure is confirmed by Infrared spectroscopy. In all syntheses, percent yields are determined.

Lab 10: In this lab, six qualitative chemical tests are performed on a simulated urine sample to demonstrate urinalysis. The tests performed are for calcium, chloride, ammonium, protein, sugar and ketones.

Suggested Timed Course Schedule (to complete the course within a typical college semester)

All Portage courses are offered asynchronously with no required schedule to better fit the normal routine of adult students, but the schedule below is suggested to allow a student to complete the course within a typical college semester. Students may feel free to complete the course on a schedule determined by them within the parameters outlined under “Course Progression.”

Time Period	Assignments	Subject Matter
Days 1-12	Module 1, Exam 1	Matter, metric measurements, atomic theory, periodic table, naming and writing of formulas
	Labs 1-2, Lab Exams 1-2	Safety/Mass/Volume, Density
Days 13-24	Module 2, Exam 2	Balancing/writing molecular and ionic reactions, redox balancing, molarity, stoichiometric calculations, percent composition, empirical formula
	Labs 3/4/9, Lab Exams 3/4/9	Quant/Qual Analysis, Reaction Chem, Inorg Synthesis
Days 25-36	Module 3, Exam 3	Kinetic-molecular theory, gas laws, quantum theory of atoms, electron configuration, periodic table, periodic properties
Days 37-48	Module 4, Exam 4	Ionic and molecular bonding, octet rule, Lewis structures, molecular geometry
	Lab 5, Lab Exam 5	Bonding by Spectroscopy and Physical Properties
Days 49-60	Module 5, Exam 5	Rate laws, reaction mechanisms, activation energy, catalysis, chemical equilibria
	Lab 6, Lab Exam 6	Chemical Equilibrium/LeChatelier's Principle
Days 61-72	Module 6, Exam 6	Acids and bases, pH calculations, titration calculations, acid-base equilibria, buffers
	Lab 7, Lab Exam 7	Acid-Base Titrations
Days 73-84	Module 7, Exam 7	Organic chemistry, spectroscopy
	Lab 8, Lab Exam 8	Organic Synthesis
Days 85-96	Module 8, Exam 8	Biochemistry, nuclear reactions, radiation, half-life
	Lab 10, Lab Exam 10	Urinalysis

Days 97-108	Final Exam	Comprehensive - including all course material

Grading Rubric:

Check for Understanding	1 pts.
8 Module Problem Sets = 5 pts. each x 8 =	40 pts.
8 Module Exams = 100 pts. each x 8 =	800 pts.
10 Lab Exams = 30 pts. each x 10 =	300 pts.
10 Lab Notebooks = 5 pts. each x 10 =	50 pts.
Final Exam = 160 pts.	160 pts.
Total	1351 pts.

The current course grade and progress is continuously displayed on the student desktop.

Grading Scale:

96.5% - 100% = A+
92.5% - 96.4% = A
89.5% - 92.4% = A-
86.5% - 89.4% = B+
82.5% - 86.4% = B
79.5% - 82.4% = B-
76.5% - 79.4% = C+
72.5% - 76.4% = C
69.5% - 72.4% = C-
66.5% - 69.4% = D+
62.5% - 66.4% = D
59.5% - 62.4% = D-
0% - 59.4% = F

Suggested External References:

If the student desires to consult a reference for additional information, the following textbooks are recommended as providing complete treatment of the course subject matter.

- Jean Umland, **General Chemistry**, West Publishing
- Darrell Ebbing, **General Chemistry**, Houghton Mifflin Publishing

NOTE: We do not support the use of outside resources to study, except the ones listed above.

Learning Support Services:

Each student should be sure to take advantage of and use the following learning support services provided to increase student academic performance:

Video lectures: Supports diverse learning styles in conjunction with the text material of each module

Messaging system: Provides individual instructor/student interaction

Tech support: Available by submitting a help ticket through the student dashboard

Accommodations for Students with Learning Disabilities:

Students with documented learning disabilities may receive accommodations in the form of an extended time limit on exams, when applicable. To receive the accommodations, the student should furnish documentation of the learning disability at the time of registration, if possible. Scan and e-mail the documentation to studentservices@portagelearning.edu. Upon receipt of the learning disability documentation, Portage staff will provide the student with instructions for a variation of the course containing exams with extended time limits. This accommodation does not alter the content of any assignments/exams, change what the exam is intended to measure or otherwise impact the outcomes of objectives of the course.

One-on-one Instruction:

Each student is assigned to his/her own instructor. Personalized questions are addressed via the Canvas messaging system.

Online learning presents an opportunity for flexibility; however, a discipline to maintain connection to the course is required; therefore, communication is essential to successful learning. **Check your messages daily.** Instructors are checking messages daily Monday-Friday to be sure to answer any questions that may arise from you. It is important that you do the same, so you do not miss any pertinent information from us.

Holidays:

During the following holidays, all administrative and instructional functions are suspended, including the grading of exams and issuance of transcripts.

New Year's Day	MLK Day
Easter	Memorial Day
Juneteenth	Independence Day
Labor Day	Thanksgiving weekend
Christmas Break	

The schedule of holidays for the current calendar year may be found under the Student Services menu at www.portagelearning.edu

Code of Conduct: Students are expected to conduct themselves in a way that supports learning and teaching and promotes an atmosphere of civility and respect in their interactions with others. Verbal and written aggression, abuse, or misconduct is prohibited and may be grounds for immediate dismissal from the program. This is a classroom; therefore, instructors have the academic freedom to set forth policy for their respective class. Class policies for individual instructors can be found in the course introductory material in Canvas. Students are required to read these policies prior to beginning the course.

Grievances: If a student has a complaint about the course, the student is advised to first consult the instructor of the course. After communicating with the instructor, if the matter is still unresolved, students may file a formal grievance for consideration by the Academic Review Committee. The process must be initiated via written communication to academics@portagelearning.edu, with “Academic Grievance” listed in the subject line of the email.

Remediation: At Portage Learning we allow a "one-time" only opportunity to re-take an alternate version of **one** module exam AND **one** lab exam on which a student has earned a grade lower than 70%. This option must be exercised before the final exam is started. If an exam is retaken, the original exam grade will be erased, and the new exam grade will become a permanent part of the course grade. However, before scheduling and attempting this retest, the student must resolve the questions they have regarding the material by reviewing both the old exam and the lesson module material. Once ready to attempt the retest of the exam they must contact their instructor to request that the exam be reset for the retest. Remember, any module retest must be requested and completed **before** the final exam is opened.

Note: Exams on which a student has been penalized for a violation of the academic integrity policy may not be re-taken.

Syllabi are subject to change as part of ongoing educational review practices. Students are responsible for accessing and using the most recent version of the course syllabus.