VYRSITY

SCIE2101 Chemistry
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I. VYRSITY PROFESSOR BIO

Jeffrey R. Christianson, Ph.D., is Professor of Science and Worldview at Vyrsity and Colorado Biblical University. He is also a Data Scientist, has previously held a Postdoctoral Researcher appointment (computational chemistry) in the Chemical Engineering department at the University of Delaware, and has served as a Graduate Researcher (theoretical physical chemistry) and Teaching Assistant (general chemistry) in the Chemistry department at the University of Wisconsin – Madison, where he received his Ph.D. in Physical Chemistry. He received B.S. degrees in Chemistry and Mathematics from Truman State University.

II. COURSE DESCRIPTION

This course provides a broad survey of the field of Chemistry for non-science majors. Learners will be introduced to atomic and molecular theory and their impact upon understanding the major concepts within the field of Chemistry, including chemical reactions, states of matter, thermodynamics, kinetics, equilibrium, organic chemistry, inorganic chemistry, and nuclear chemistry. The course is designed to equip the Learner with an understanding of and appreciation for the state of modern Chemistry, the historical context of its major developments, and the interplay between inductive and deductive thought that is common among all natural sciences, thereby providing information, experience, and tools necessary for a worldview-informed treatment of science in transformative learning and leadership.

Module 1: Introduction to Chemistry, Atoms, Molecules, and Ions
Chemistry: Atoms First 2e (1.1 – 1.6, 2.1 – 2.4)
Problem Set #1
Module Assessment #1

What is chemistry? Why and how did the field of modern chemistry develop? Why and how is atomic theory foundational to modern chemistry? Upon completion of this module, the Learner will be able to explain the fundamental components of atomic theory, outline the historical context and major experiments that led to its development, interpret and use modern atomic symbols, and perform basic computations related to atomic theory including atomic mass calculations and unit conversion to moles.

Module 2: Electronic Structure and Periodic Properties of Elements
Chemistry: Atoms First 2e (3.1 – 3.6)
Problem Set #2
Module Assessment #2
Journal Question #1

What is the modern understanding of the nature of light and how did it develop historically? What is the modern understanding of the electronic structure of atoms and how did it develop historically? Upon successful completion of this module, the Learner will be able to explain the fundamental components of both the nature of light and the electronic structure of atoms, explain how the former informs the latter, and perform related basic computations involving the energy associated with different frequencies of light and quantized energies of one electron within an atom. The Learner will also be able to identify major periodic trends in properties of the elements.

Module 3: Chemical Bonding and Molecular Geometry
Chemistry: Atoms First 2e (Chapter 3.7, 4.1 – 4.6)
Problem Set #3
Module Assessment #3
Journal Question #2

How do atoms bond to one another? How was this discovered? Upon successful completion of this module, the Learner will be able to explain how the electronic structure of atoms informs an understanding of chemical bonding, identify the nature of different bonds ranging from ionic to pure covalent, draw Lewis structure representations of simple molecules, and describe those structures in terms of the ideas of formal charge and resonance.

Module 4: Substance Composition and Introduction to Chemical Reactions
Chemistry: Atoms First 2e (6.1 – 6.3, 7.1 – 7.5)
Problem Set #4
Module Assessment #4

How and why are quantities of atoms and molecules measured? How and why are changes in substance composition categorized and tracked? Upon successful completion of this module, the Learner will be able to define empirical and molecular formulas and determine them from gravimetric experimental data, define solution concentration in terms of molarity, balance and classify simple chemical reactions, and calculate and explain quantitative results of chemical reactions based upon their stoichiometry.

Module 5: States of Matter: Gases, Liquids, and Solids
Chemistry: Atoms First 2e (8.1 – 8.3, 10.1 – 10.2, 10.5)
Problem Set #5
Module Assessment #5
Journal Question #3

How do gas, liquid, and solid phases of the same substance differ? How did the modern understanding of these differences develop historically? Upon successful completion of this module, the Learner will be able to explain the differences between gas, liquid, and solid phases in terms of intermolecular forces, identify mathematical relationships between properties of gases, and use the ideal gas law to compute various properties of pure and mixed gases.

Module 6: Introduction to Thermochemistry and Thermodynamics
Chemistry: Atoms First 2e (9.1 – 9.2, 12.1 – 12.3)
Problem Set #6
Module Assessment #6

What is energy? How does it change forms during chemical and physical processes? How were these concepts discovered historically? Upon successful completion of this module, the Learner will be able to explain the basic concepts of energy and how chemical heat transfer can be measured using calorimetry, distinguish between spontaneous and non-spontaneous processes using the concept of entropy, explain the motivation for each of the three fundamental laws of thermodynamics, and perform basic calculations associated with calorimetry and spontaneity.

Module 7: Introduction to Kinetics and Equilibrium
Chemistry: Atoms First 2e (17.1 – 17.3, 17.5, 13.1 – 13.3)
Problem Set #7
Module Assessment #7
Journal Question #4

How and why are rates of chemical reactions determined? How do chemical processes eventually reach a state of equilibrium? Upon successful completion of this module, the Learner will be able to define and calculate reaction rates from simple experimental data, describe major factors that affect reaction rates,

explain the basic concepts of collision theory, describe the nature of chemical systems at equilibrium and how it can be shifted, and carry out basic calculations involving the reaction quotient and equilibrium constant.

Module 8: Introduction to Solubility and Acid-Base
Chemistry: Atoms First 2e (11.1 – 11.3, 15.1, 14.1 – 14.3~~, 15.2~~)
Problem Set #8
Module Assessment #8

How does dissolution and precipitation occur? What are acids and bases? How did these concepts facilitate the development of modern chemistry? Upon successful completion of this module, the Learner will be able to define, describe, and carry out related equilibrium constant calculations for the dissolution process, electrolytes, solubility, precipitation, acids, bases, pH, and pOH. In addition, the Learner will be able to rationalize macroscopic observations of each of these concepts in terms of microscopic, molecular-level interactions.

Module 9: Introduction to Organic and Inorganic Chemistry
Chemistry: Atoms First 2e (21.1 – 21.4, 19.1 – 19.2)
Problem Set #9
Module Assessment #9

How do substances prevalent in living things differ from those prevalent in metal-based materials? How and why did the historical understanding of such different substances develop? Upon successful completion of this module, the Learner will be able to describe structures, properties, and examples of major classes of organic compounds (hydrocarbons, alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, and amides). The Learner will also be able to describe properties, structures, coordination, and examples of transition metal compounds and complexes.

Module 10: Nuclear Chemistry
Chemistry: Atoms First 2e (20.1 – 20.6)
Problem Set #10
Module Assessment #10
Journal Question #5
Course Assessment

How does nuclear chemistry differ in process and effect from electronic chemistry and how did its discovery impact the development of atomic theory? Upon successful completion of this module, the Learner will be able to define nuclear structure and stability, write and balance nuclear equations, describe and analyze common radiometric dating techniques, explain the basic concepts of nuclear fission and fusion processes, and describe and analyze various uses and effects of nuclear chemistry.

III. COURSE READING

Flowers, Paul; Neth, Edward; Robinson, William R.; Theopold, Klaus; Langley, Richard. *Chemistry: Atoms First 2e* (Houston, TX: OpenStax, Feb 14, 2019), ISBN: 978-1-947172-63-0, https://openstax.org/details/books/chemistry-atoms-first-2e, Free Online (open source, hard copy retail: $55), sections as specified for each module.

IV. LEARNING OUTCOMES

Course Learning Outcomes (CLOs)

1. Understand the major concepts within the field of Chemistry and how and why they developed (VLO 1, 2, BPCO 1, APCO 1).

2. Apply knowledge of these major concepts to solve problems that are regularly addressed by chemists (VLO 3, BPCO 2, APCO 1).
3. Analyze common scientific ideas and examine their major epistemological presuppositions and implications (VLO 4, 5, BPCO 3, 4, APCO 2, 3).

Bachelor's Program Competency Outcomes (BPCOs)

1. To prepare Learners for roles in transformative education teaching and service.
2. To provide Learners a foundation for effective individual and organizational leadership in diverse environments.
3. To ensure Learners demonstrate worldview foundation for empowering people and building communities.
4. To help Learners formulate a Biblical approach to transformative learning and leadership.

Associate's Program Competency Outcomes (APCOs)

1. To prepare Learners for specialized undergrad study in transformative education theory and in leadership strategies.
2. To provide Learners key worldview foundations for critical thinking and study.
3. To provide Learners with practical experience germane to their transformative learning and leadership.

Vyrsity Learning Outcomes (VLOs)

1. Critical Thinking, Problem Solving, and Research – Learners will demonstrate ability to think critically, solve problems, and conduct interdisciplinary research at a level appropriate to their program.

2. Personal Growth – Learners will understand how learning is related to personal growth, and will be challenged to grow in their thinking, communication, conduct, and engagement with others.

3. Skills Development – Learners will advance in skills related to their program, demonstrating a level of competency appropriate to their program.

4. Social Responsibility – Learners will appreciate the diversity in and value of others as designed by our Creator, and will grow in willingness and capability to serve others.

5. Worldview Applications – Learners will become capable at thinking from a worldview perspective understanding the relationship of description and prescription, so that they can ground their actions in sound principles.

V. GRADING RUBRIC (1000 POINTS)

Module Assessments (50 points each x 10)	500 Points (Multiple Choice + Work)
Competency Assessments (50 points each x 5)	250 Points (Journal Question/Essay Response)
Course Assessment	250 Points (Multiple Choice + Work)

Problem sets will be assigned for each module that are essential to achieving CLOs 1-2. Answers to each problem in the problem set will be provided so that the Learner may self-assess his or her understanding prior to taking a graded assessment. As such, it is highly recommended that the Learner thoroughly work through each problem set using available resources (course textbook, lecture material, mentor, etc.) prior to looking up the answers and grading the problem set. After self-grading, any incorrect answers should then be thoroughly investigated until the correct understanding and answer is achieved.

Module and Course Assessments are the graded components of the course that will evaluate the Learner's progress in achieving CLOs 1-2. Each assessment will have a time limit for completion that reflects minimal time required to answer all questions if CLOs 1-2 have been achieved. Available resources such as the course textbook and lecture material may be consulted during the assessment (e.g., to reference constants, symbols, or conversion factors that have not quite been memorized by working through the problem sets), but there will not be time to research every tested concept. Each question will be multiple choice, but some questions will explicitly state that work must be shown. In this case, the Learner must write down the key computation(s) required to answer the question. Immediately following the exam, a copy of this work (e.g., scan or picture) must be uploaded to Populi for review. Uploaded work should reflect the answers that were selected, in which case the points reserved for showing work will be assigned at the same percentage as the percentage of correct answers selected on the assessment (for example, if 70% of the multiple-choice questions were answered correctly and 10 points are reserved for showing work, then 7 of those 10 points will be assigned).

Competency Assessments are the graded components of the course that will evaluate the Learner's progress in achieving CLO 3. Each one will consist of a journal question that will require the Learner to analyze the course material from the perspective of his or her worldview. The first submitted response should be a critical analysis with a coherent written structure. In most cases, at least one subsequent response based on mentor feedback or questions will also be required. Points will be assigned based on all submitted responses.

VI. GRADING SCALE

91-100%	A
81-90%	B
71-80%	C
61-70%	D
0-60%	F

VII. CARNEGIE UNIT CREDIT HOUR EQUIVALENT

Total Hours of Module Content:	30 hours
Total Hours of Reading Content:	30 hours
Total Hours of Practice Problems:	35 hours
Total Hours of Journal Questions:	25 hours
Total Hours of Minor Assessments:	12 hours
Total Hours of Major Assessment:	3 hours

Equivalent of 3 Credit Hours (135 hours of total course time)