Fiscal Unit/Academic Org	Chemistry - D0628
Administering College/Academic Group	Arts and Sciences
Co-adminstering College/Academic Group	Graduate School
Semester Conversion Designation	New Program/Plan
Proposed Program/Plan Name	Advanced Chemistry Knowledge for Educators
Type of Program/Plan	Graduate certificate program
Program/Plan Code Abbreviation	CHEMCCC
Proposed Degree Title	Advanced Chemistry Knowledge Certification

Credit Hour Explanation

Program credit hour requirements		A) Number of credit hours in current program (Quarter credit hours)	B) Calculated result for 2/3rds of current (Semester credit hours)	C) Number of credit hours required for proposed program (Semester credit hours)	D) Change in credit hours
Total minimum credit hours required for completion of program				18	
Required credit hours offered by the unit	Minimum			18	
	Maximum			18	
Required credit hours offered outside of the unit	Minimum			0	
	Maximum				
Required prerequisite credit hours not included above	Minimum			0	
	Maximum				

Program Learning Goals

Note: these are required for all undergraduate degree programs and majors now, and will be required for all graduate and professional degree programs in 2012. Nonetheless, all programs are encouraged to complete these now.

Program Learning Goals

- Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Adapt educational resources to support General Chemistry instruction based on one’s learning objectives and the setting in which the resources are to be used.
- Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Collaborate on teacher inquiry projects based on topics of their choosing.

Assessment

Assessment plan includes student learning goals, how those goals are evaluated, and how the information collected is used to improve student learning. An assessment plan is required for undergraduate majors and degrees. Graduate and professional degree programs are encouraged to complete this now, but will not be required to do so until 2012.

Is this a degree program (undergraduate, graduate, or professional) or major proposal? No

Program Specializations/Sub-Plans

If you do not specify a program specialization/sub-plan it will be assumed you are submitting this program for all program specializations/sub-plans.

Pre-Major

Does this Program have a Pre-Major? No

Attachments

- CCP program goals.docx: Program Goals and Assessment Plan
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- CCP program CBC approval.pdf: Grad Program Approval
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- CBC certificate letter College Endorsement.docx: College Endorsement
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- Assessment Plan December 2019.docx: Detailed Assessment Plan
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- Syllabus Course Chem 6086.docx: Revised Chem 6086 Syllabus
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- Syllabus Course Chem 6087.docx: Revised Chem 6087 Syllabus
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- Syllabus Course Chem 6088.docx: Revised Chem 6088 Syllabus
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- Syllabus Course Chem 6089.docx: Revised Chem 6089 Syllabus
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- CCP Advising Sheet.docx: Advising Sheet
  (Other Supporting Documentation. Owner: Ramirez,Ana G)
- Graduate Certificate Proposal.docx: Program Proposal
  (Program Proposal. Owner: Ramirez,Ana G)

Comments

- Please make number adjustments to the advising sheet and the certificate completion sheet. *(by Vankeerbergen,Bernadette Chantal on 01/09/2020 11:21 AM)*
- 10/15/19: Returned to the unit due to ad hoc'ing error.
  01/08/20: ad hoc'd to Bernadette. *(by Haddad,Deborah Moore on 01/08/2020 10:42 AM)*
- Please ad hoc proposal to Bernadette Vankeerbergen for college level review *(by Pearce,Laura Elizabeth on 10/15/2019 08:15 AM)*
- Course proposals have been submitted for review concurrently with the program proposal. *(by Ramirez,Ana G on 10/11/2019 09:13 AM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Ramirez,Ana G	10/11/2019 10:33 AM	Submitted for Approval
Approved	Gustafson,Terry Lee	10/11/2019 11:32 AM	Unit Approval
Approved	Haddad,Deborah Moore	10/11/2019 04:02 PM	College Approval
Revision Requested	Pearce,Laura Elizabeth	10/15/2019 08:15 AM	GradSchool Approval
Submitted	Ramirez,Ana G	10/15/2019 03:03 PM	Submitted for Approval
Approved	Wade,Christine M.T	10/15/2019 03:14 PM	Unit Approval
Approved	Haddad,Deborah Moore	10/15/2019 03:17 PM	College Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	01/03/2020 03:46 PM	Ad-Hoc Approval
Submitted	Ramirez,Ana G	01/06/2020 01:49 PM	Submitted for Approval
Approved	Gustafson,Terry Lee	01/06/2020 01:54 PM	Unit Approval
Approved	Haddad,Deborah Moore	01/06/2020 05:20 PM	College Approval
Revision Requested	Pearce,Laura Elizabeth	01/07/2020 12:13 PM	GradSchool Approval
Submitted	Ramirez,Ana G	01/07/2020 04:15 PM	Submitted for Approval
Approved	Gustafson,Terry Lee	01/07/2020 04:24 PM	Unit Approval
Approved	Haddad,Deborah Moore	01/08/2020 09:33 AM	College Approval
Revision Requested	Pearce,Laura Elizabeth	01/08/2020 09:50 AM	GradSchool Approval
Submitted	Ramirez,Ana G	01/08/2020 09:52 AM	Submitted for Approval
Approved	Gustafson,Terry Lee	01/08/2020 10:06 AM	Unit Approval
Approved	Haddad,Deborah Moore	01/08/2020 10:42 AM	College Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	01/09/2020 11:21 AM	Ad-Hoc Approval
Submitted	Ramirez,Ana G	01/09/2020 01:49 PM	Submitted for Approval
Approved	Gustafson,Terry Lee	01/09/2020 01:52 PM	Unit Approval
Approved	Haddad,Deborah Moore	01/09/2020 03:33 PM	College Approval
Revision Requested	Pearce,Laura Elizabeth	01/09/2020 03:37 PM	GradSchool Approval
Submitted	Ramirez,Ana G	01/09/2020 06:24 PM	Submitted for Approval
Approved	Gustafson,Terry Lee	01/09/2020 06:34 PM	Unit Approval
Pending Approval	Vankeerbergen,Bernadette Chantal	01/09/2020 06:46 PM	Ad-Hoc Approval
Approved	Haddad,Deborah Moore	01/09/2020 06:46 PM	College Approval

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Offices of the Associate
and Assistant Deans

114 University Hall
230 North Oval Mall
Columbus, OH 43210

614-292-1667 Phone
asc.osu.edu

October 10, 2019

I am pleased to offer the College of Arts and Sciences' support for the proposed stand-alone graduate certificate in "Advanced Chemistry Knowledge for Educators." This proposed certificate will become part of a larger ASC initiative (supported by OAA) to provide College Credit Plus authorization programs in several fields for qualified high school teachers.

We are particularly pleased that CBC has developed this as an online program, which will undoubtedly enhance its reach and sustainability. We hope the other existing CC+ teacher programs (in English, Math, and Physics) will follow this example and develop online versions of their programs as well. In addition to CBC's efforts, ASC is working with ESCCO (Educational Service Center of Central Ohio) and Columbus State Community College to facilitate teacher access to our programs.

Sincerely,

Steve Fink

Associate Executive Dean

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Department of Chemistry and Biochemistry

Christine M. Thomas
Fox Professor of Chemistry
Vice Chair of Graduate Studies
100 W. 18th Ave
Newman-Wolfram Laboratory 3109
Columbus, OH 43210
thomasc@chemistry.ohio-state.edu

October 8, 2019

Dear ASC Curriculum Committee,

The Department of Chemistry and Biochemistry Graduate Studies Committee supports the proposed graduate academic certificate program and the four associated course proposals. This program will provide a valuable opportunity for high school chemistry teachers who want to further their chemistry education so that they can become accredited to teach College Credit Plus chemistry courses.

Sincerely,

Christine M. Thomas
Vice Chair of Graduate Studies
Department of Chemistry and Biochemistry

ASC Proposal Guidelines

1. Required Information

Name: Advanced Chemistry Knowledge for Educators. Type 3A Stand Alone Certificate.

Delivery: Combination of synchronous and asynchronous online courses.

Proposed implementation: Initial cohort begins summer 2020.

Academic units responsible for certificate administration: Department of Chemistry and Biochemistry, College of Arts and Sciences.

Description: The type 3A stand along certificate "Advanced Chemistry Knowledge for Educators" consists of a total of 18 credit hours distributed across four online courses. The certificate is designed to enhance the skills of high teachers, or those interested in becoming high school teachers, and provide accreditation to teach College Credit Plus chemistry courses. The proposed curriculum will begin in summer 2020. We anticipate an initial cohort of 8-10 students during the first year. Our goal is to award 30 certificates in the first three years of the program.

2. Rationale

Under the 2014 state law known as the "College Credit Plus Program," minimum credentials have been established for instruction in College Credit Plus (CCP) courses. High school teachers who wish to be the instructors of record for survey-level college courses need one of the following: a Master's degree in the content area, or a Master's degree in a different area plus 18 graduate credits in the content area. The Department of Chemistry and Biochemistry has developed an 18-credit certificate to meet the needs of high school teachers who already possess a Master's degree and who seek to be credentialed to teach College Credit Plus courses in Chemistry. This certificate provides evidence that a teacher possesses the minimum academic qualifications to teach CCP courses.

In the state of Ohio, total College Credit Plus enrollment was nearly 70,000 students in the 2016-2107 academic school year. The most common delivery method for these courses is by a credentialed high school instructor. Science is a subject taken by a significant number of students, trailing only English and Social Sciences. However, many high school science teachers lack the appropriate credentials to teach CCP Chemistry courses, and there are limited opportunities to earn these credentials in Ohio. This certificate program will address this need.

Student demand for the proposed certificate include 1) experienced teachers in Ohio currently teaching high school Chemistry course but are not eligible to teach CCP courses, 2) individuals completing a Masters of Education (MEd) program and who plan to teach CCP courses, 3) educators outside of Ohio seeking graduate credits in Chemistry in order to teach CCP-equivalent courses in their own states.

Upon completion of the academic certificate in the Advanced Chemistry Knowledge for Educators program, learners will be better prepared to 1) design a General Chemistry CCP course comparable to undergraduate courses in the Ohio, 2) deliver the course with an understanding of advanced, foundational content knowledge, 3) evaluate student achievement in the course.

3. Relationship to Other Programs

This certificate does not overlap with other programs or departments within the university.

This certificate has not been previously submitted for approval.

The University of Toledo currently offers an online program leading to the credentialing of CCP teachers in Chemistry as part of its Masters of Science and Education program.

4. Student Enrollment

We anticipate an initial cohort of 8-10 students during the first year. Our goal is to award 30 certificates in the first three years of the program. Efforts will be made to recruit teachers, both in Ohio and nationwide, using networks such as the American Modeling Teachers Association and regional National Science Teachers Association (NSTA) conferences. These efforts will include seeking to enroll underrepresented participants in STEM. STEM students who have completed the OSU Masters of Education program will also be targeted.

5. Curricular Requirements

A minimum of 18 credits is required for completion of the certificate. The curriculum is a four-course sequence. Courses are intended to be taken in order, although this is not a requirement.

- Summer: Online course (5 credit)
- Fall: Online course (4 credit)
- Spring: Online course (4 credit)
- Summer: Online course (5 credit)

The time to completion is a maximum of four years. The recommended curriculum is four semesters (summer, autumn, spring, summer).

Certificate Completion Sheet

Department of Chemistry and Biochemistry, The Ohio State University

Advanced Chemistry Knowledge for Educators, Type 3A Stand Alone Certificate

Student Name:

Student OSU Email:

Certificate Advisor Name:

Coursework

Course (hours)	Course Grade	Term Completed
Chemistry 6086, Advanced Chemistry Knowledge for Educators: Atomic Structure and Quantum Mechanics (5 credits).		
Chemistry 6087, Advanced Chemistry Knowledge for Educators: Bonding Models and States of Matter (4 credits).		
Chemistry 6088, Advanced Chemistry Knowledge for Educators: Kinetics, Thermodynamics, and Equilibrium (4 credits)		
Chemistry 6089, Advanced Chemistry Knowledge for Educators: Modern Applications and Instrumental Analysis (5 credits)		

Substitutions Approved:

Certificate Advisor Signature:

Date:

The Ohio State University
Arts and Sciences

Graduate Academic Certificate Advanced Chemistry Knowledge for Educators

Ted Clark, Associated Associate Professor

Department of Chemistry and Biochemist
110 Celeste Laboratory
120 West 18th Avenue
Columbus, OH 43210
Tel: 614-292-1204
Email: clark.789@osu.edu
Department website: https://chemistry.osu.edu/

Overview

Graduate Academic Certificate Program: Post-Bachelor Degree Stand-Alone Certificate Advanced Chemistry Knowledge for Educators consists of a total of 18 credit hours distributed across four online courses. The certificate is designed to enhance the skills of high teachers, or those interested in becoming high school teachers, and provide accreditation to teach College Credit Plus chemistry courses.

Certificate Requirements

Four required courses (18 credits).

Chemistry 6086 – Atomic Structures and Quantum Mechanics (5 credits)

Chemistry 6087 – Bonding Models and States of Matter (4 credits)

Chemistry 6088 – Kinetics, Thermodynamics, and Equilibrium (4 credits)

Chemistry 6089 – Modern Applications and Instrumental Analysis (5 credits)

Advanced Chemistry Knowledge for Educators program guidelines

Credit hours required
A minimum of 18 hrs. Credits must be at the 6000 level.

Overlap with courses in degree
Not Permitted. Pursued as independent of program.

Grades required
- Minimum C- for a course to be counted on the certificate.
- Minimum 3.00 cumulative point-hour ratio required for the certificate.
- Course work graded Pas/Non-Pass cannot be applied toward the certificate.

X193 credits
Not permitted.

Approval required
The certificate must be approved by the academic unit.

Filing the certificate program form
The certificate program form must be filed at least by the time the graduation application is submitted to a college/school counselor.

Changing the certificate
Once the certificate program is filed in the college office, any changes must be approved by the academic unit offering the certificate

THE OHIO STATE UNIVERSITY

CHEMISTRY 6086 –Advanced Chemistry Knowledge for Educators: Atomic Structure, Energy, and Quantum Mechanics.

Summer 2020 (Online). 5 credit hours

Instructor Information

Instructor:	Ted M. Clark	Office:	120 Celeste Lab
Email:	Clark.789@osu.edu	Office Hours:	---

Course Description: For professionals and educators seeking an advanced understanding of General Chemistry content knowledge with consideration of how this understanding informs teaching and learning in College Credit Plus Chemistry courses. Topics typically found in the first semester of General Chemistry will be investigated, including scientific measurement and error analysis, the historical underpinnings of atomic structure leading to a quantum mechanical model, atomic properties, and energy and thermodynamics.

Prerequisites: Enrollment in Advanced Chemistry Knowledge for Educators Certificate Program.

Required General Chemistry Textbooks

- Chemical Principles, The Quest for Insight (7th edition) by Atkins, Jones, Laverman. Printed copy or eText.
- Chemistry, The Central Science (14th Ed.) electronic textbook by Brown, LeMay, Bursten, Murphy, Woodward, & Stoltzfus, paired with the online homework system MasteringChemistry, will be provided.

How This Course Works

Mode of delivery: This course is 100% online. There are not required sessions when you must be logged in to Carmen at a scheduled time.

Pace of online activities: This course is divided into 3 modules: 1) review and analysis of General Chemistry course content, 2) teacher inquiry research project, 3) communicating findings and adapting resources. All of the modules will be open the entire semester, but there will be checkpoints along the way to monitor progress. Students are expected to keep pace with these checkpoints, but may schedule their efforts freely within that time frame. Students may also work ahead of schedule.

Credit hours and work expectations: This is a 5-credit-hour course. According to OSU guidelines, students should expect around 5 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 10 hours of homework (reading, writing papers) to receive an average grade (in this graduate course it is a B grade).

Attendance and participation: Attendance is based on your online activity. During most weeks you will probably log in to the course in Carmen multiple times. Office hours and live sessions are optional.

Discussion forum: An online discussion board will be used with every module. This is a place where you can share ideas, comments, and questions with the instructor and your classmates.

Course Objectives

Upon successful completion of this course, you should:

- Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.
- Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Complete a collaborative teacher inquiry project based on a topic, or topics, of your choosing. Potential topics include:
  - Scientific measurement, error analysis, propagation of uncertainties, statistical analysis.
  - The First Law of thermodynamics, temperature, heat and work, enthalpy, heat capacity.
  - Experiments leading to a modern understanding of the atom, and how these experiments illustrate themes from the Nature of Science (NOS), including the development of conceptual models.
  - Experiments involving radiation and photons, such as blackbody radiation and the photoelectric effect, and their role leading to the quantum hypothesis.
  - Operator algebra and postulates of Quantum theory.
  - Knowing the form of solutions to the Schrōdinger equation, such as a particle in a box and a harmonic oscillator, and how these ideas inform General Chemical pedagogy.
  - The Pauli Exclusion principle and Heisenberg's Uncertainty principle.
  - Photoelectron spectroscopy and X-ray fluorescence spectroscopy, and how these can be used to support a discussion of electronic structure.
- Communicate research findings in a paper synthesizing chemistry knowledge and classroom pedagogy.

Grading

Grades are based on assignments divided into three broad modules:

Module 1: Review and analysis of General Chemistry course content (25% of total).

Module 2: Teacher Inquiry Research Project (50% of total).

Module 3: Communicating Findings and Adapting Resources (25% of total).

Overall grades are based on 1000 points:

A > 920 points. A- = 900 – 919 points.

B+ = 880 – 899 points. B = 820 – 879 points. B- = 800 – 819 points.

C+ = 780 – 799 points. C = 750 – 779 points.

Course Information & Policies

Title IV Attendance Requirement: Federal policy requires that attendance for all university students be verified during the first week of classes

STANDARDS OF ACADEMIC CONDUCT IN GENERAL CHEMISTRY

Violations of academic standards in General Chemistry will be referred to the University Committee of Academic Misconduct (COAM) as required by Faculty Rules. It is the responsibility of COAM to investigate all reported cases of student academic misconduct; illustrated by, but not limited to, cases of plagiarism and any dishonest practices in connection with examinations, quizzes, and graded assignments. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information see the Code of Student Conduct: studentlife.osu.edu/csc

Student Responsibilities: *Any graded material must represent your own work.* Unauthorized group efforts by students, use of another student's course materials, or assistance from individuals who already have taken the course, could place you in jeopardy of violation of the standards for the course. In some courses, group work is acceptable on certain activities (as explicitly stated by your instructor). In these cases, it is important that you know and understand where authorized collaboration (working in a group) ends and collusion (working together in an unauthorized manner) begins. Identical answers indicate copying or unacceptable group efforts - always answer questions in your own unique words. It is important that you consult with your instructor for clarification on whether or not collaboration is appropriate on an activity. *You should not assist others in violating academic standards*. Students supplying materials for others to "look at" may be charged with academic misconduct.

Commitment to Diversity: The Department of Chemistry and Biochemistry promotes a welcoming and inclusive environment for all students and staff, regardless of race, gender, ethnicity, national origin, disability or sexual orientation. There is no tolerance for hateful speech or actions. All violations of this policy should be reported to the OSU Bias Assessment and Response Team (BART, studentaffairs.osu.edu/bias). The Department encourages diversity at all levels, particularly among the next generation of scientists. Students are encouraged to participate in organizations that provide support specifically for science and engineering students who are African-American, Asian, disabled, Hispanic, LGBTQ or women. These organizations are listed on the Colleges of Arts and Sciences (artsandsciences.osu.edu/stem-organizations) and Engineering (engineering.osu.edu/studentorgs) websites.

Disability Services: The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), reasonable accommodations can be established. Students should first register with Student Life Disability Services, then meet with the General Chemistry SLDS Coordinator in the Undergraduate Studies Office (Holly Wheaton) who will assist you in establishing your accommodations in the course.

Contact SLDS
Email: slds@osu.edu
Phone: 614-292-3307
Address: 098 Baker Hall
Website: slds.osu.edu

Contact Holly Wheaton
Email: genchem@osu.edu
Phone:614-292-6009
Address:110 Celeste Lab

THE OHIO STATE UNIVERSITY

CHEMISTRY 6087 –Advanced Chemistry Knowledge for Educators: Bonding Models and States of Matter.

Autumn 2020 (Online) 4 credit hours

Instructor Information

Instructor:	Ted M. Clark	Office:	120 Celeste Lab
Email:	Clark.789@osu.edu	Office Hours:	---

Course Description: For professionals and educators seeking an advanced foundational and historical understanding of General Chemistry content knowledge with consideration of how this understanding informs teaching and learning in College Credit Plus Chemistry courses. A variety of bonding models will be examined, ranging from Lewis structures to valence bond theory to molecular orbital theory. The properties of ideal gases, real gases, liquids, solids, and aqueous solutions, will be discussed macroscopically and explained at the sub-microscopic level.

Prerequisites: Enrollment in Advanced Chemistry Knowledge for Educators Certificate Program.

Required General Chemistry Textbooks

- Chemical Principles, The Quest for Insight (7th edition) by Atkins, Jones, Laverman. Printed copy or eText.
- Chemistry, The Central Science (14th Ed.) electronic textbook by Brown, LeMay, Bursten, Murphy, Woodward, & Stoltzfus, paired with the online homework system MasteringChemistry, will be provided.

How This Course Works

Mode of delivery: This course is 100% online. There are not required sessions when you must be logged in to Carmen at a scheduled time.

Pace of online activities: This course is divided into 3 modules: 1) review and analysis of General Chemistry course content, 2) teacher inquiry research project, 3) communicating findings and adapting resources. All of the modules will be open the entire semester, but there will be checkpoints along the way to monitor progress. Students are expected to keep pace with these checkpoints, but may schedule their efforts freely within that time frame. Students may also work ahead of schedule.

Credit hours and work expectations: This is a 4-credit-hour course. According to OSU guidelines, students should expect around 4 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 8-10 hours of homework (reading, writing papers) to receive an average grade (in this graduate course it is a B grade).

Attendance and participation: Attendance is based on your online activity. During most weeks you will probably log in to the course in Carmen multiple times. Office hours and live sessions are optional.

Discussion forum: An online discussion board will be used with every module. This is a place where you can share ideas, comments, and questions with the instructor and your classmates.

Course Objectives

Objectives

Upon successful completion of this course, you should:

- Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.
- Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Complete a collaborative teacher inquiry project based on a topic, or topics, of your choosing. Potential topics include:
  - Historical origins of the octet rule, and how it frequently impedes conceptual understanding in General Chemistry.
  - Lewis structures and VSEPR predicted molecular geometry,
  - Bonding models, including valence bond theory and molecular orbital theory.
  - Properties of states of matter.
- Communicate research findings in a paper synthesizing chemistry knowledge and classroom pedagogy.

Grading

Grades are based on assignments divided into three broad modules:

Module 1: Review and analysis of General Chemistry course content (25% of total).

Module 2: Teacher Inquiry Research Project (50% of total).

Module 3: Communicating Findings and Adapting Resources (25% of total).

Overall grades are based on 1000 points:

A > 920 points. A- = 900 – 919 points.

B+ = 880 – 899 points. B = 820 – 879 points. B- = 800 – 819 points.

C+ = 780 – 799 points. C = 750 – 779 points.

Course Information & Policies

Title IV Attendance Requirement: Federal policy requires that attendance for all university students be verified during the first week of classes

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Website: slds.osu.edu

Contact Holly Wheaton
Email: genchem@osu.edu
Phone:614-292-6009
Address:110 Celeste Lab

THE OHIO STATE UNIVERSITY

CHEMISTRY 6088 –Advanced Chemistry Knowledge for Educators: Kinetics, Thermodynamics, and Equilibrium.

Spring 2021 (Online). 4 credit hours

Instructor Information

Instructor:	Ted M. Clark	Office:	120 Celeste Lab
Email:	Clark.789@osu.edu	Office Hours:	---

Course Description: For professionals and educators seeking an advanced foundational and historical understanding of General Chemistry content knowledge with consideration of how this understanding informs teaching and learning in College Credit Plus Chemistry courses. Topics pertaining to equilibrium, such as solubility and acid-base chemistry will be investigated and described using kinetic and thermodynamic-based explanations.

Prerequisites: Enrollment in Advanced Chemistry Knowledge for Educators Certificate Program.

Required General Chemistry Textbooks

- Chemical Principles, The Quest for Insight (7th edition) by Atkins, Jones, Laverman. Printed copy or eText.
- Chemistry, The Central Science (14th Ed.) electronic textbook by Brown, LeMay, Bursten, Murphy, Woodward, & Stoltzfus, paired with the online homework system MasteringChemistry, will be provided.

How This Course Works

Mode of delivery: This course is 100% online. There are not required sessions when you must be logged in to Carmen at a scheduled time.

Pace of online activities: This course is divided into 3 modules: 1) review and analysis of General Chemistry course content, 2) teacher inquiry research project, 3) communicating findings and adapting resources. All of the modules will be open the entire semester, but there will be checkpoints along the way to monitor progress. Students are expected to keep pace with these checkpoints, but may schedule their efforts freely within that time frame. Students may also work ahead of schedule.

Credit hours and work expectations: This is a 4-credit-hour course. According to OSU guidelines, students should expect around 4 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 8-10 hours of homework (reading, writing papers) to receive an average grade (in this graduate course it is a B grade).

Attendance and participation: Attendance is based on your online activity. During most weeks you will probably log in to the course in Carmen multiple times. Office hours and live sessions are optional.

Discussion forum: An online discussion board will be used with every module. This is a place where you can share ideas, comments, and questions with the instructor and your classmates.

Course Objectives

Objectives

Upon successful completion of this course, you should:

- Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.
- Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Complete a collaborative teacher inquiry project based on a topic, or topics, of your choosing. Potential topics include:
  - Thermodynamics as a driving force used to explain chemical phenomena.
  - Kinetics.
  - Equilibrium.
  - Activity.
  - Acid-base reactions and solution stoichiometry.
- Communicate research findings in a paper synthesizing chemistry knowledge and classroom pedagogy.

Grading

Grades are based on assignments divided into three broad modules:

Module 1: Review and analysis of General Chemistry course content (25% of total).

Module 2: Teacher Inquiry Research Project (50% of total).

Module 3: Communicating Findings and Adapting Resources (25% of total).

Overall grades are based on 1000 points:

A > 920 points. A- = 900 – 919 points.

B+ = 880 – 899 points. B = 820 – 879 points. B- = 800 – 819 points.

C+ = 780 – 799 points. C = 750 – 779 points.

Course Information & Policies

Title IV Attendance Requirement: Federal policy requires that attendance for all university students be verified during the first week of classes

STANDARDS OF ACADEMIC CONDUCT IN GENERAL CHEMISTRY

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Student Responsibilities: *Any graded material must represent your own work.* Unauthorized group efforts by students, use of another student's course materials, or assistance from individuals who already have taken the course, could place you in jeopardy of violation of the standards for the course. In some courses, group work is acceptable on certain activities (as explicitly stated by your instructor). In these cases, it is important that you know and understand where authorized collaboration (working in a group) ends and collusion (working together in an unauthorized manner) begins. Identical answers indicate copying or unacceptable group efforts - always answer questions in your own unique words. It is important that you consult with your instructor for clarification on whether or not collaboration is appropriate on an activity. *You should not assist others in violating academic standards*. Students supplying materials for others to "look at" may be charged with academic misconduct.

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Contact SLDS **Contact Holly Wheaton**

Email: slds@osu.edu
Phone: 614-292-3307
Address: 098 Baker Hall
Website: slds.osu.edu

Email: genchem@osu.edu
Phone:614-292-6009
Address:110 Celeste Lab

THE OHIO STATE UNIVERSITY

CHEMISTRY 6089 –Advanced Chemistry Knowledge for Educators: Modern Applications & Instrumental Analysis.

Summer 2021 (Online). 5 credit hours

Instructor Information

Instructor:	Ted M. Clark	Office:	120 Celeste Lab
Email:	Clark.789@osu.edu	Office Hours:	---

Course Description: For professionals and educators seeking an advanced understanding of General Chemistry content knowledge with consideration of how this understanding informs teaching and learning in College Credit Plus Chemistry courses. Topics from General Chemistry are discussed with emphasis on modern applications, including electrochemistry, nuclear chemistry, materials, and leading approaches involving instrumental analysis.

Prerequisites: Enrollment in Advanced Chemistry Knowledge for Educators Certificate Program.

Required General Chemistry Textbooks

- Chemical Principles, The Quest for Insight (7th edition) by Atkins, Jones, Laverman. Printed copy or eText.
- Chemistry, The Central Science (14th Ed.) electronic textbook by Brown, LeMay, Bursten, Murphy, Woodward, & Stoltzfus, paired with the online homework system MasteringChemistry, will be provided.

How This Course Works

Mode of delivery: This course is 100% online. There are not required sessions when you must be logged in to Carmen at a scheduled time.

Pace of online activities: This course is divided into 3 modules: 1) review and analysis of General Chemistry course content, 2) teacher inquiry research project, 3) communicating findings and adapting resources. All of the modules will be open the entire semester, but there will be checkpoints along the way to monitor progress. Students are expected to keep pace with these checkpoints, but may schedule their efforts freely within that time frame. Students may also work ahead of schedule.

Credit hours and work expectations: This is a 5-credit-hour course. According to OSU guidelines, students should expect around 5 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 10 hours of homework (reading, writing papers) to receive an average grade (in this graduate course it is a B grade).

Attendance and participation: Attendance is based on your online activity. During most weeks you will probably log in to the course in Carmen multiple times. Office hours and live sessions are optional.

Discussion forum: An online discussion board will be used with every module. This is a place where you can share ideas, comments, and questions with the instructor and your classmates.

Course Objectives

Upon successful completion of this course, you should:

- Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.
- Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Complete a collaborative teacher inquiry project based on a topic, or topics, of your choosing. Potential topics include:
  - Electrochemistry and electrochemical applications.
  - Nuclear Chemistry and radiometric analysis.
  - Coordination compounds.
  - Materials Science.
  - Computational chemistry
  - Atomic spectroscopy: Mass spectrometry, flame atomic absorption spectrometry, emission spectrometry
  - Molecular spectroscopy: Ultraviolet/Visible molecular absorption spectrometry, infrared spectrometry, and nuclear magnetic resonance spectroscopy.
  - Voltammetry and Coulometry.
  - Gas chromatography and high performance liquid chromatography.
- Communicate research findings in a paper synthesizing chemistry knowledge and classroom pedagogy.

Grading

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Module 1: Review and analysis of General Chemistry course content (25% of total).

Module 2: Teacher Inquiry Research Project (50% of total).

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Overall grades are based on 1000 points:

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Program Goals:

Upon completion of the program students will be able to:

(Goal 1) Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.

(Goal 2) Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.

(Goal 3) Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.

(Goal 4) Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.

(Goal 5) Collaborate on teacher inquiry projects based on topics of their choosing.

Assessment Plan

Goal 1 will be assessed by applying rubrics for lesson plans that integrate, and describe the use of, delivery of content, homework, practice exams, and other class resources

Goal 2 will be assessed by using exams.

Goal 3 will be assessed by using rubrics.

Goal 4 will be assessed by evaluating student writing of literature reviews.

Goal 5 will be assessed through the use of student writing assignments, including ones that include quantitative and qualitative data analysis.

Assessment Plan

Direct measures will be used to assess the proposed graduate certificate. Direct measures will include analysis of data directed tied to program learning outcomes.

Data Collection
Learning outcomes and Assignments

- Outcome: Synthesize methods, practices, and resources appropriate for teaching undergraduate General Chemistry with a deep understanding of fundamental topics that inform pedagogical decisions.
- Assignment: Student-generated **lesson plans** based on learning objectives that guide the integration, and use of, lessons, activities, homework, practice exams, and other class resources. A given lesson plan corresponds to a typical chapter of content in an undergraduate General Chemistry course. Lessons plans are usually 1-3 pages in length.

Lesson Plan Assignments

Chem 6086	Chem 6087	Chem 6088	Chem 6089
Measurement. Discovery of Atomic Structure. Energy, the First Law of Thermodynamics. Electronic Structure of Atoms. Quantum Mechanics.	Periodic Properties and Ionic Bonding. Lewis Structures and VSEPR. Valence Bond Theory and Molecular Orbital Theory. Gases, Liquids, Intermolecular Forces. Solids and Materials.	Properties of Solutions. Chemical kinetics and Equilibrium. Acid-Base Equilibria. Solubility and Complex Ion Equilibria. Entropy and Free Energy.	Electrochemistry Nuclear Chemistry Atomic Spectroscopy Molecular Spectroscopy Separation Methods

- Outcome: Demonstrate an awareness of the range and depth of topics in undergraduate General Chemistry courses, along with mastery of these topics.
- Assignment: **Exams** are intended to assess competency and communicate the format of typical tests, and the range and depth of topics found in undergraduate General Chemistry courses. Exams are 20-30 multiple choice questions and are completed in a single 75-minute period. Each course will include two exams.

- Outcome: Adapt educational resources to support General Chemistry instruction based on one's learning objectives and the setting in which the resources are to be used.
- Assignment: **Design instructional activities**. Activities may take many different, such as worksheets, computer simulations (like PhET) that are instructor or student-led, demonstrations, chapter reading guides, and laboratory experiments. They should be included in the corresponding lesson plan and have a supporting rationale. The scope of the activity is open-ended, e.g. it may be a week-long experiment or a targeted worksheet.

- Outcome: Use primary research articles to connect an advanced understanding of scientific ideas with their teaching and learning in General Chemistry.
- Assignment: A **literature review** that must include at least 5 primary research article references, with at least 2 primary references being found by the student. Each article is to be reviewed in one or two paragraphs, and the entire review must have a cohesive framework including an introduction and a conclusion.

- Outcome: Complete a collaborative teacher inquiry project based on a topic, or topics, of your choosing.
- Assignment: The **teacher inquiry project** is a collaboration between student(s) and the instructor. The overarching research question is "How does a deeper understanding of 'topic x' inform your own instructional practices, and how can it inform the practices of others?' Students have an opportunity to select both their own topic, and the format of the final product, e.g. it may be a paper, research poster, or narrated slide presentation. The topic will be selected by the student in the first one-third of the course. The first draft will be due at approximately two-thirds of the way through the course. Based on student interest, a broader dissemination of findings may be possible outside of the course setting, including at regional science education conferences. This assignment is graded in two stages. It is likely that significant changes and improvements will be made following feedback on the first draft.

Data analysis

Qualitative data, such as lesson plans and the literature review, will be coded using a phenomenographic methodology. In this approach, the coding will be used to investigate the different ways teachers experience their learning of content knowledge fundamental to General Chemistry at a graduate-level vis-à-vis their classrooms, students, and pedagogical content knowledge. This information will be paired with other descriptors, such as years in the profession and teaching philosophy, to consider whether a deeper content understanding influences teacher pedagogical content knowledge and leads to specific changes in their practices. Results from the teacher inquiry project and the design of instructional activities are additional data sources to be used to investigate the manner in which teachers do, or do not, plan to modify their practices. Quantitative data from exams will be used gauge basic teacher content knowledge, which will then be considered as part of a larger description of their self-

efficacy as teachers. Attention will be directed to investigate whether teacher's perceptions of their own self-efficacy are improved or diminished, by taking these courses, both at the topic level and for the courses as a whole.