

INDIANA UNIVERSITY

CHEM-T 540: Physical Chemistry

Full Fall 2023: 8/21/23 - 12/15/23

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1. Course Number and Title

CHEM-T 540; Physical
Chemistry

2. Credit Hours

3.0

3. Campus

IU

4. Professor

Victor F. Waingeh

5. Course Description

CHEM-T540 is a graduate level course that will touch on all the fundamental areas of Physical Chemistry (kinetics, thermodynamics, equilibrium, quantum). Knowing that one course cannot sufficiently cover all the areas of physical chemistry in one semester, focus and emphasis is on content that expands the students' knowledge in these key areas beyond what is expected at undergraduate level and relates to concepts that are likely to be taught in high school and introductory chemistry courses. A key aspect will be to develop students' understanding of advanced physical chemistry concepts and ability to apply this knowledge towards fundamental chemistry concepts and problems through quantitative problem solving, discussions and presentations.

Course Content

The course will follow the molecular approach to physical chemistry, beginning with the quantum mechanical description of matter before proceeding to bulk properties.

- Quantum Mechanics
 - o Historical background, postulates, and general principles of quantum mechanics
 - o Schrodinger equation and a particle in a box
 - o Atomic and molecular structure (chemical bonding)
 - o Spectroscopy (Microwave, IR, NMR)

- Thermodynamics & Equilibrium
 - o Equation of State, First & Second Laws of Thermodynamics
 - o Thermodynamics in engines and refrigeration
 - o Chemical Equilibrium
 - o Thermodynamics of pure systems and mixtures
 - o Phase equilibria

- Chemical Kinetics
 - o Fundamentals of reaction rates, rate laws
 - o Nonelementary reaction kinetics

- o Influence of reactor type, transport limitations and phase equilibria on reaction rates

6. Course Goals and Student Learning Outcomes

CHEM-T540 supports the Principles of Graduate Education. The course objectives contribute towards achievement of program objectives for the IU Graduate Certificate in Chemistry.

1. Students will demonstrate expertise in Physical Chemistry
 - a. Students will be able to breakdown and analyze fundamental physical chemistry concepts and processes
 - b. Students will be able to apply advanced physical chemistry knowledge in explaining fundamental chemistry concepts and solving problems.
 - c. Students will be able to design and present methodologies to teach fundamental physical chemistry concepts
2. Students will demonstrate effective oral and written scientific communication skills
 - a. Students will be able to retrieve information from chemical literature and critically analyze a journal article
 - b. Students will be able to communicate scientific findings and information in both written and oral form
3. Students will demonstrate applications of the impact of Physical Chemistry on society
 - a. Students will be able to analyze processes in everyday life using physical chemistry principles
 - b. Students will demonstrate an awareness of the impact of physical chemistry on the society

Alignment of Course Level Objectives (CLOs) to Program Level Objectives (PLOs)

Program Level Outcomes	Course Level Outcomes	Learning/Assessment Instrument
1. Expertise in chemistry Students will be able to: <ol style="list-style-type: none"> a. Demonstrate the ability to break down and analyze chemical concepts and processes. b. Demonstrate an achievement of breadth of knowledge across a selection of sub disciplines in Chemistry. c. Design assignments to teach relevant chemical concepts. 	Students will demonstrate expertise in Physical Chemistry <ol style="list-style-type: none"> a. Students will be able to breakdown and analyze fundamental physical chemistry concepts and processes b. Students will be able to apply advanced physical chemistry knowledge in explaining fundamental chemistry concepts and solving problems. c. Students will be able to design and present methodologies to teach fundamental physical chemistry concepts 	<ul style="list-style-type: none"> - Assignments, quizzes and exams on specific content - Forum discussions - Concept paper & presentation
2. Effective oral and written scientific communication skills Students will be able to: <ol style="list-style-type: none"> a. Retrieve information from the chemical literature. b. Communicate understanding of literature. 	Students will demonstrate effective oral and written scientific communication skills Students will be able to: <ol style="list-style-type: none"> a. retrieve information from chemical literature and critically analyze a journal article b. communicate scientific findings and information in both written and oral form 	<ul style="list-style-type: none"> - Literature review - Forum discussions - Concept paper and presentation

<p>3. Ability to analyze data critically and to design experiments independently Students will be able to:</p> <ol style="list-style-type: none"> Develop methodological approaches and solve problems. Critically analyze a journal article. 	<p>Partly achieved through CLO 1c & 2a</p>	<ul style="list-style-type: none"> - Literature reviews - Forum discussions - Concept paper and presentation
<p>4. Application of the impact of chemistry on society Students will be able to:</p> <ol style="list-style-type: none"> Analyze processes in everyday life using chemical principles. Demonstrate an awareness of the impact of chemistry on the environment, society, and other cultures outside the scientific community. Evaluate chemistry-related press releases and news media for veracity and best practices in research. 	<p>Students will demonstrate application of the impact of Physical Chemistry on society</p> <ol style="list-style-type: none"> Students will be able to analyze processes in everyday life using physical chemistry principles Students will demonstrate an awareness of the impact of physical chemistry on society 	<ul style="list-style-type: none"> - Forum discussions - Literature reviews

7. Learning Materials

Main Text: D. A. McQuarrie & J. D. Simon: Physical Chemistry – A Molecular Approach. 1st Ed.

Other Useful Resources:

- o Atkins and de Paula: Physical Chemistry. 10th Ed;
- o I.N. Levin: Physical Chemistry. 6th Ed.

8. Assessment

Tool	%Grade	Expectation	Score basis
biweekly discussions forums (5 pts each)	10%	Post an opinion on topic and react to other opinions. Topics will relate to the teaching of certain concepts or the application of Physical chemistry concepts in everyday life	Completion, evidence-based or concept-guided (substantiated) opinions. Rubrics
Weekly Homework problems (10 pts each)	20 %	Complete and submit weekly homework problems from topics covered	Answer Key
Literature Reviews & Discussions	30%	Complete review of journal articles (x3), write and submit short critical analysis, engage in discussions with others	Rubrics
Concept Paper & Presentation	10%	Write and submit a 10-page paper on a topic of choice (from a list of topics) on the practical application of physical chemistry or the teaching of a physical chemistry topic at high school/introductory level: Supporting evidence	Rubric & Peer Evaluation

		should include at least two peer-reviewed scholarly sources	
Exams	30%	Exam (x2) on concepts covered during the semester	Answer Key

Letter Grade: $90 \leq \mathbf{A} \leq 100$; $80 \leq \mathbf{B} \leq 89.99$; $70 \leq \mathbf{C} \leq 79.99$; $60 \leq \mathbf{D} \leq 69.99$