

Items highlighted in yellow represent emendations that will be added if the course receives a QAR GE certification.

## CHM 4 Chemistry, Culture, & Society

Schedule: Monday, Wednesday, and Friday 8:00 – 9:05 AM

Location: Adams Center Room 219

Instructor: Stephen M. Contakes

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### A. Instructor & office hours information:

#### **Lecture Instructor:**

Stephen M. Contakes

Office: Whittier Science 218

Phone/Voicemail: (805) 565-7153

Cell phone: (626) 676-5084 (8 AM – 9 PM or emergencies only)

Fax: (805) 815-7066

E-mail: [scontakes@westmont.edu](mailto:scontakes@westmont.edu)

#### *Office hours:*

Mondays and Friday's 9:15-10:30 AM, Wednesdays 11:30 AM – 2 PM, & by appointment.

#### **Teaching Assistant/Grader/Discussion group leader:**

Leandra Marshall

### B. Course Description (from the University Catalogue, starting 2019-2020 academic year):

**CHM 4 Chemistry, Culture, and Society (4)** Survey course that teaches the basic concepts of chemistry. Key episodes in the history of chemistry are used to develop an understanding of how science functions and describe modern ideas about matter, including atomic-molecular theory, energy, chemical periodicity, chemical bonding, and molecular structure. This understanding is then used to describe the chemistry of petroleum derivatives, plastics, living systems, food, drug action, chemically-intensive agriculture, the environment, and contemporary energy technologies. The course also considers the impact of chemical technology on society by exploring chemistry's benefits and environmental, human health, and social risks associated with the development, manufacture, and use of chemicals. As part of this exploration students are urged to consider the relationships between science, technology, and Christian thought and practice.

### C. Instructional goals & objectives:

#### **Student Learning Outcomes (SLOs):**

1. You will become acquainted with some of the major historical episodes & ideas associated with the development of chemistry as an intellectual discipline with the goal of helping you to understand how the scientific method can be used to investigate the physical and living world.
2. You will develop an ability to use the language and symbolism of chemistry to communicate and understand chemical concepts.
3. You will develop an ability to apply mathematical reasoning to work with scientific quantities; understand how scientific inferences are formed; analyze and calculate the properties of elements, compounds, and reaction systems; interpret trends in the use and impact of chemicals in human society and the wider

environment; and, as appropriate, make decisions about the best way to address a chemical problem. The specific quantitative literacy skills you will be expected to demonstrate involve

- The representation and interpretations of scientific quantities using units, scientific notation, and prefixes.
  - The calculation of scientific quantities using proportional reasoning, algebraic analysis, percentages, and fractions.
  - The representation and interpretation of data using various types of tables and graphs.
  - The drawing of logical inferences using quantitative scientific data
4. You will learn the basic postulates of atomic-molecular theory and understand how it can be used to explain the properties of solids, liquids, gases, and solutions both in general and in terms of particular substances.
  5. You will learn how chemical bonds and intermolecular forces form, what properties they confer on the chemical systems that possess them, and how they can be used to understand the properties of inorganic salts, small molecule organic compounds, organic polymers, biochemical systems, and pharmaceuticals.
  6. You will develop a conceptual understanding of chemical reactions, learn how they are represented in chemical equations, and then apply that understanding to the calculation of the quantities of materials involved in a chemical reaction.
  7. You will become more aware about how chemical technology impacts human history and culture and understand a few contemporary issues raised by the large-scale application of chemical technology.
  8. Among the former you will gain an understanding of the chemistry involved in creating, assessing, and alleviating various environmental issues. Specifically you will consider the impacts of humankind's use of energy and fuels; pesticides, fertilizers, and other agricultural chemicals; and the widespread availability of inexpensive non-biodegradable plastics.
  9. You will gain an understanding of approaches to risk and chemical regulation that are commonly used to address the real or potential adverse impacts associated with the use of chemicals.
  10. You will gain some understanding of how chemical knowledge and technology raises issues for and helps shape philosophical, theological, pastoral, and/or ethical discourse in Christian communities. .

### **General Education Learning Outcomes**

This course fulfils Westmont's *Exploring the Physical Sciences GE* requirement. Specifically,

1. Through SLOs 1-5 you will develop an understanding of the basic properties of matter and the principles that govern its behaviour.
2. Through SLO 1's historical approach you will have an opportunity to learn about how science worked in practice and develop a nuanced understanding of how science works. These episodes will also acquaint you with the character of scientific models, their predictive power, and the role of data, hypotheses, and theories in guiding scientific research.
3. Use your knowledge of science to investigate various science-related issues that affect individuals and society, especially in areas related to human health, energy, agriculture, the environment, and the risks and benefits of humankind's use of chemicals.
4. Through SLOs 1, 6- 10 (primarily) you will have an opportunity to reflect on various points of current and historical contact between Christianity and chemistry. These include what Christian theology has to say about matter and the scientific study of matter, the history of Christian thinking about atomic views of matter, the interrelationship between chemistry and various trends in natural theology, the interrelationship between various understandings of Christian environmental stewardship and the culture mandate, public policy principles and tools for addressing risk, and the responsibilities of Christians who wish to develop and deploy various chemical technologies.
5. Be able to articulate your view of the relationship between faith and science and the views of others using categories from recognized typologies of science and religion.

This course also fulfils Westmont's *Quantitative and Analytical Reasoning GE* requirement.

Specifically, it requires you to

1. Make use of mathematical models that describe the behaviour of chemical systems, most notably the experiment-based modelling which culminated in the development of modern

atomic theory, mathematical models describing the behaviour of light, geometric models that describe molecular shapes and polarity, stoichiometric models for the calculation of material compositions and chemical reaction outcomes, and thermodynamic models that describe the flow of energy in physical and chemical systems.

2. Use units, prefixes, conversion factors, and mathematical relationships to assess and calculate scientific quantities and to track mass and energy flows in chemical systems.
3. Reflect on the strengths and weaknesses of various models for the fundamental structure of matter, especially in terms of assessing quantitative evidence for atomic views of matter and the plum pudding, solar system, and quantum mechanical models of atomic structure.
4. Use various types of graphs, charts, and tabular data to quantitatively assess various issues associated with the use of chemicals in society. These include the scale of humankind's use of various natural resources, the contributions of various human activities to those uses, and various correlative and predictive models for assessing the likely impact of those activities.
5. Reflect on the actual and potential implications of scientific data and models for personal, economic, and public policy decision making.

These skills will be developed through in-class presentations and worked examples and assessed through homework assignments and exams.

### **Course Topics**

- Atoms, elements, chance, necessity, and explanation in chemistry's history
- Scientific quantities, units, prefixes, and conversion factors
- Atoms in the scientific revolution and the scientific method
- Atoms, the periodic table, and quantum mechanics
- Compounds, bonding, and molecular structure
- Polarity, intermolecular forces, and the properties of matter
- The anthropic principle and what, if anything, it might mean.
- Chemical reactions & reaction stoichiometry
- Chemistry and climate
- Hydrocarbons and petroleum chemistry
- Polymers and materials chemistry
- Functional hydrocarbons
- How do chemists' use light and other tools to figure out molecules' structure?
- Life and Biochemistry
- Origin of life chemistry, molecular evolution, and human origins
- Medicinal chemistry, antibiotics, & the Pill,
- Neurochemistry & psychotropic medications
- Chemical Thermodynamics
- Energy from fossil fuels and renewable sources
- Environmental element cycles
- Christianity and environmental stewardship
- Chemical technology, values, and society
- Responsible chemistry in the wake of several 20<sup>th</sup> Century chemical disasters, most notably those associated with Thalidomide and DDT

### **D. Educational goals and teaching procedures**

1. Mini-lectures and sample problems will be used to explain and clarify the course material and to help you understand which topics are important.
2. In-class discussions and debates will be used to help you explore how chemistry impacts society and to help you think about the relationship of chemistry to the Christian faith.
3. Readings will be used to acquaint you with and reflect on the course material as well as to provide a base of information for your reference, study, and review.
4. Periodic homework sets will be used to help you keep up with the material, enable me to track your progress, and to prepare you for in-class discussions.
5. Homework assignments will also give you an opportunity to develop a deeper knowledge of course material and to help you develop problem-solving skills.
6. Optional problem-solving review sessions will be used to further help you hone your problem-solving skills and clarify your understanding of course concepts.

7. Exams, the first two of which will almost exclusively focus on technical subjects, will be used to solidify your knowledge and evaluate your progress.
8. Demonstrations and a lab tour will be used to acquaint you with some of the equipment and instruments chemists use in their daily work.

### E. Textbooks, Materials, and Resources:

#### Required Textbooks:

- Tro, N. *Chemistry in Focus*, 3<sup>rd</sup> or 4<sup>th</sup> or 5<sup>th</sup> or 6<sup>th</sup> edition. The official edition is the 5<sup>th</sup> (ISBN-13: 0-495-60551-4) but all should work equally well and you might find that earlier ones can be obtained quite cheaply used on Amazon)
- Chappell, D. F.; Cook, E. D. *Not Just Science: Questions Where Christian Faith and Natural Science Intersect* Zondervan, 2005. ISBN 13: 978-0-310-26383-8 (Note: This book can be obtained quite cheaply used on Amazon)
- Hoffman, R. *The Same and Not the Same*, Cornell University Press, 1997. ISBN-13: 978-0231101394 (Note: This book can be obtained quite cheaply used on Amazon)
- Handout packet (obtained from the instructor)

#### Required online homework software:

- Sapling Learning Online Homework (One-Term Access): ISBN 978-0-9833859-5-0.

#### Required materials:

- Notebook
- Scientific calculator (This must be able to handle scientific notation. Since you will largely need this for exams and homework assignments you should feel free to borrow one from a science major)

#### Suggested materials

- 3-ring binder to hold course handouts (you may use the hold punch in the chemistry department if you decide to go this route)

### F. Method of Grading:

The evaluation segments are weighted as follows:

Midterm Exams	44% (22% each)
Final Exam	36%
Homework assignments & practice exams	15% (1% for HW1-9.11-13; 3% for HW 10)
Discussion participation, in-class activities, quizzes	4%
Lab tour	1%
<b>Total</b>	<b>100%</b>

Letter grades are assigned based on the collected final point percentage where A equals an exceptional, B a superior, C an average, and D a poor result. An F indicates the student has not mastered the material sufficiently to receive any credit for the course. I reserve the right to curve individual and final grades but guarantee the following letter grades or better if you achieve the following pre-curve percentages:

A	92.5-100%	C	72.5-77.4%
A-	90.0-92.4%	C-	70.0-72.4%
B+	87.5-89.9%	D+	67.5-69.9%
B	82.5-87.4%	D	62.5-67.4%
B-	80.0-82.4%	D-	60.0-62.5%
C+	77.5-79.9%	F	≤59.9

Incomplete grades will only be considered for medical/disability or significant personal reasons (*i.e.* death of a close relative, etc.). Medical reasons must be documented by a physician and disability related issues documented by Sheri Noble, Westmont's Director of Disability Services (see the

course policies on the following page). Which personal reasons are significant will be determined by the instructor.

## G. Course Policies

### *General Conduct:*

As far as possibly, I expect you to conduct yourselves with courtesy, dignity, honesty, and discretion as befitting Christian men and women. This includes but is not limited to honesty in completion of course assignments, prompt attendance at lectures, not repeatedly going in and out of lecture, not talking while the instructor or other students are speaking, and seeking to treat others with courtesy, humility, and Christian love. Students violating course conduct policies may be admonished or asked to leave the room at the discretion of the instructor. Repeated or particularly severe violations may result in more serious sanctions (such as being dropped from the course with a WF) at the discretion of the instructor and/or other members of the Westmont college faculty and staff as appropriate. Harassment of others based on sex, race, national origin, sexual orientation, or any other category protected by law will not be tolerated and can result in serious sanctions both in this course and with the college.

### *Exams:*

Attendance at exams is mandatory. You will need a scientific calculator for exams. Students are not permitted to leave and re-enter the room during an exam. If a university-sponsored excuse has been presented to the instructor *prior* to the absence or if a medical reason can be proven, tests can be taken at an alternate date determined by the instructor. Other types of absences or lateness will not allow the test to be taken at a later point.

### *Homework Assignments:*

These are due at the start of class on the appropriate due date, although I reserve the right to collect all or part of particular homework assignments at the end of class or not at all in cases where doing so might aid student learning. These cases may change unexpectedly so please complete each homework assignment as fully as possible before arriving.

Note that many of the homeworks have online components and/or require you to read articles or watch short videos as part of the assignment. Because of this it may take you longer to complete each assignment than you might think from a quick look at the handout or sapling learning webpage. Consequently you are encouraged to start work on each assignment early and complete as much of the assignment as you can after each class period.

You are encouraged to work together with other students on the homework outside of class. However, each student is individually responsible for being able to explain the work they submit.

### *In Class Assignments*

Periodic individual and group work in-class assignments will be given. These will be graded based on participation and effort. As such it is necessary for you to attend class on these days to receive credit for these assignments. However, if you need to miss one or more of these assignments for an excused absence (athletics, class field trips, etc.) or for a medical or family emergency please see the instructor as soon as possible to arrange to complete these or alternative assignments.

### *Lab tour:*

Since there is no lab in this course on **Monday, October 24**, I would like you to go on an approximately one hour tour of the Westmont chemistry lab facilities on the 2<sup>nd</sup> floor of the Whittier Sciences building. Three tours are available – right after class, at 2 PM, and at 5 PM.<sup>1</sup> All lab tours will gather on the patio outside Adams 219. Please contact me if your schedule does not permit you to attend any of these sessions.

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<sup>1</sup> The lab tours have been scheduled for the period after the class session on “Molecules, light, & structure” in order to maximize your ability to appreciate the tour.

*Late work policy:*

Late assignments will only be accepted in the event work cannot be turned in on time due to severe sudden illness or significant personal reasons – as determined by the instructor. Please see the instructor ASAP in such cases to make alternate arrangements. The reasons given for the late/absent work must be documented within one week of the completion of the illness/personal event. No more than three assignments may be missed in this manner without incurring an incomplete in the course.

*Electronic equipment (cell phones, laptops, calculators, etc...):*

Electronic equipment may be freely used during lectures as long as they do not distract the attention of other students. In this context, the instructor reserves the right to determine whether a particular in-class use of electronic equipment is distracting. The instructor also reserves the right to revoke usage of particular equipment at any time if he deems its use to be detrimental to the class or individual students. Please leave the room to conduct or receive phone calls. You may not use any electronic equipment other than calculators during exams. Any student found using unapproved electronic materials in these contexts will receive a grade of zero for the exam.

*Academic Dishonesty:*

Evidence of academic dishonesty, including plagiarism and cheating on exams, will result in a zero for the particular assignment. A second offence will result in withdrawal from the course with a grade of F. As per Westmont college policy all instances of academic dishonesty will be reported to the provost's office for possible further action at their discretion.

Note that plagiarism covers more than verbatim copying of material; it can include copying another student's flow of thoughts and ideas. Because of this those of you who work together with other students are particularly invited to read Westmont College's plagiarism policy for guidance ([http://www.westmont.edu/offices/provost/plagiarism/plagiarism\\_policy.html](http://www.westmont.edu/offices/provost/plagiarism/plagiarism_policy.html)) and to talk with the instructor about any doubtful cases that might arise.

*Disability/Medical:*

Exceptions to the course policies will only be considered for disability reasons or serious sudden medical or personal emergencies. Students who have been diagnosed with a disability (learning, physical or psychological) are strongly encouraged to contact the Disability Services office (Please contact the Director of Disability Services, Sheri Noble ([snoble@westmont.edu](mailto:snoble@westmont.edu)) as early as possible to discuss appropriate accommodations for this course. Formal accommodations will only be granted for students whose disabilities have been verified by the Disability Services office. These accommodations may be necessary to ensure your full participation and the successful completion of this course. Serious sudden emergencies must be documented and discussed with the instructor within one week of the student's return to campus.

**H. Disclaimer:**

The course schedule, topics, assignments, etc... presented in this syllabus are offered in good faith. However, these may be changed at the instructor's discretion with the caveat that additional assignments, tests, and quizzes will not be capriciously imposed on the students.

## **Tentative Course Schedule (subject to change depending on the pace of the class)**

Key to abbreviations:

- Tro = Tro, N. *Chemistry in Focus*, 4<sup>th</sup> ed. Brooks-Cole, 2009.
- Hoffman = Hoffman, R. *The Same and Not the Same*, Cornell University Press, 1997
- Not Just Science = Chappell, D. F.; Cook, E. D. *Not Just Science: Questions Where Christian Faith and Natural Science Intersect* Zondervan, 2005.

Examples:

Tro sect. 1.1-1.2 = Chapter 1, sections 1.1 and 1.2 of *Chemistry in Focus*, 4<sup>th</sup> ed.

Hoffman Ch. 1 = Chapter 1 of *The Same and Not the Same*

Read Not Just Science, "Are Pharmaceutical Drugs Good or Bad?" (pgs. 228-234) = Read the section entitled "Are Pharmaceutical Drugs Good or Bad?" on pages 228-234 of *Not Just Science*.

<b>Date:</b>	<b>Topic</b>	<b>Assignment:</b>
<i>August</i>		
Mon. 29	Course Overview & Intro. to Chemistry in Society	Read Tro Sect. 1.1-1.2
Wed. 31	Chemistry's early beginnings & the Scientific Revolution	Read Tro Sect. 1.4-1.6
<i>September</i>		
Fri. 2	The rise of atomic theory and "the scientific method"	Read Tro Sect. 1.3, 1.6 (reread), 1.9
Mon. 5	Exploring Atomic Theory Part 1: Classifying Matter & introduction to solution chemistry	Read "How have Christian faith and natural Science interacted throughout history?" ( <i>Not Just Science</i> pgs. 27-47) Read Tro Sect. 1.7
Wed. 7	Exploring Atomic Theory Part 2: States of Matter, Change, and Energy	Read Tro Sect. 1.8
Fri. 9	The Chemist's Toolbox Part 1: Quantities, Units, and Conversion factors	<b>Homework 1 is due</b> Read Tro Sect. 2.1-2.6
Mon. 12	The Chemists' Toolbox Part 2: Problem Solving & the Nuclear Atom	Read Tro Sect. 2.7, 1.9
Wed. 14	<ul style="list-style-type: none"><li>• Atoms, Isotopes, and Elements</li><li>• The Periodic Table</li></ul>	Read Tro Sect. 3.1-3.5, 3.7
Fri. 16	Light, Matter, and Quantum Mechanics, Day 1	<b>Homework 2 is due</b> Read Tro Sect. 7.2-7.3
Mon. 19	Light, Matter, and Quantum Mechanics, Day 2	Read Tro Sect. 7.1, 7.4-5
Wed. 21	Light, Matter, Quantum Mechanics, Day 3 Discussion: "Is Evolution – oops I mean - Atomic-Molecular theory 'only a theory?'" and "Are Ian Barbour's "Science and Religion" typology useful for understanding how and why people raise the issue?"	<b>Homework 3 is due</b> Models for Relating Science & Religion (handout)
Fri. 23	How science works – a second look Catch-up and review for exam 1	Read "Laws, hypotheses, and theories" reference sheet (handouts) <b>Homework 4, a.k.a. practice exam 1, is due</b>
Mon. 26	<b>Exam 1</b>	
Wed 28	<ul style="list-style-type: none"><li>• Go over exam 1</li><li>• Compounds and formulas (if time permits)</li></ul>	

Fri 30	Compounds & formulas – bonding & formulas, & names <i>(Continued)</i>	Read Tro Sections 4.1 - 4.4
October		
Mon 3	Names & molar masses	Read Tro Sections 4.5 - 4.6, naming compounds reference sheet (handout)
Wed 5	Covalent bonds and Lewis Theory	Read Tro Sections 5.1-2, 4-5 <b>Homework 5 is due</b>
Fri 7	Molecule's shapes and polarity	Read Tro 5.6-5.7, 12.1-4, writing Lewis structures and determining molecular shapes reference card (handout)
Mon 10	Fall Holiday – No class	
Wed 12	Exploring Atomic-Molecular Theory: Polarity and Properties: Solutions, Soaps, and membranes <b>Discussion: What is the Anthropic principle and is it useful?</b>	Read "Cross Traffic between Science and Theology" (handout) <b>Homework 6 is due</b>
Fri 14	Chemical reactions and equations Chemistry of fuels and climate change, part 1: <b>What is the impact of a tank of gasoline?</b>	Read Tro 4.7- 4.8
Mon 17	Organic compounds – Hydrocarbons	Read Tro sections 6.1-6.6 and Hoffman Chapters 1-2 & 7
Wed 19	Organic compounds – Hydrocarbons, polymers, petroleum chemistry, and introduction to functional hydrocarbons <b>Discussion: Plastics problems and solutions?</b>	Read Tro sections 6.7-6.14
Fri 21	Organic compounds – Functional hydrocarbons Start molecules, light, & structure	Identifying organic compounds reference sheet (handout) <b>Homework 7 is due</b>
Mon 24	Molecules, light, & structure <b>Lab tours after class and at 2 and 5 PM (note: only attend one)</b>	Read Tro Sections 7.4 & 7.6 and Hoffman Chapters 3-6; Review Organic compounds review sheet (handout)
Wed 26	Catch-up and review for exam 2	<b>Homework 8, including practice exam 2, is due</b>
Fri 28	<b>Exam 2</b>	
Mon 31	Go over Exam 2 (time permitting) <b>Discussion: What is life?</b>	
November		
Wed 2	Biochemistry – Fats and Carbs	Read Tro Sections 16.1-16.3
Fri 4	Biochemistry – Proteins & nucleic acids	Read Tro Section 16.4-16.7 and Hoffman 9-10
Mon 7	The Origin of Life, Genes, & Molecular Evolution: Some Science	Read "Is there meaning beyond the biomolecular?" ( <i>Not Just Science</i> 234-242) <b>Homework 9 is due</b>
Wed 9	<b>Discussion: Biochemistry, Genes, Meaning, &amp; Human Origins: Why is the evolution issue such a big deal for American Christians?</b>	<b>Homework 10 – part 1 is due</b>

Fri 11	Continued discussion: Biochemistry, Genes, Meaning, & Human Origins: What are the positions and why do people hold them?	<b>Homework 10 – part 2 is due</b>
Mon 14	Molecules, medicine, and society: Antibiotics & “the pill”	Read Tro sections 17.1-17.4 <b>Homework 10 – part 3 is due</b>
<i>November</i>	(continued)	
Wed 16	Discussion: “What, if anything, can evangelicals learn from the Roman Catholic Church’s encounter with ‘the pill’?” Molecules, medicine, & society: Neurochemistry and Mental Health	Read Tro sections 17.5-17.7 <b>Homework 11 – Part 1 is due</b>
Fri 18	Discussion: Drugs, responsibility, healing, enhancement, and medicalization?	Read Tro sections 17.8-17.14 <b>Homework 11 – Part 2 is due</b>
Mon 21	Energy for today – Concepts and Laws	Read Tro sections 9.1-9.5
Wed 23	Thanksgiving Holiday	
Fri 25	Thanksgiving Holiday	
Mon 28	Energy for today – energy, combustion, and matter Chemistry of fuels and climate change, part 2: Discussion: Fracking: The environment’s friend or foe?	Read Tro sections 9.6 – 9.12
Wed 30	Energy and pollution: problems and solutions Discussion: What might a realistic solution to the global warming problem look like?	Read Tro 10.1-10.10 <b>Homework 12 is due</b>
<i>December</i>		
Fri 2	Chemical equilibrium, ammonia synthesis, modern agriculture, and the nitrogen cycle Fritz Haber: A Chemical Morality Tale? Discussion: Do those who develop science and technology have any responsibility to the rest of us?	Read Tro section 8.6 Hoffmann, Chapter 33 <b>Homework 13 – part 1 is due</b>
Mon 5	Molecules, Risk, & Harm: Drugs & Thalidomide Discussion: Who is responsible for the challenges of chemistry?	Read Hoffman Chapters 27-28 <b>Homework 13 – part 2 is due</b>
Wed 7	Molecules, Risk, & Harm: DDT and the environment Discussion: DDT - Good for me? Good for anybody?	
Fri 9	Catch up and course evaluations	<b>Homework 13 - Sapling is due</b>
Mon 12	(Optional) study day final exam review session	
Tue 13 <sup>th</sup>	<b>Final Exam from Noon – 2 PM</b>	