

# Materials for a Sustainable Future

How can a technological society sustain itself in a future that promises diminishing resources — and increasing demand for those resources? This puzzle won't be solved easily, but one thing is clear: it will require the holistic, intelligent application of several technologies, including renewable energy, energy-efficiency, a ubiquitous telecommunications infrastructure, high-density information storage, inexpensive sensors, and personalized medicine. How do these technologies work, and how do we improve them? What resources do they require? Are they ultimately sustainable? If not, can we ultimately transform them into sustainable technologies?

These questions are fundamentally about **materials** that possess the right set of **physical properties**. Research in materials science is driven by two goals: (a) Manipulating the chemical and physical structure of materials to control their properties, and (b) assembling materials — with the right properties — into heterogeneous systems that perform specific **functions**.

Understanding these goals requires a sound grasp of fundamental chemical principles that permeate all of molecular science. You were introduced to most of them in the fall semester of introductory chemistry. In this semester, we will build upon this knowledge and introduce advanced principles, including: solid-state chemistry, organic and inorganic polymers, electronic structure, thermodynamics, electrochemistry, excited-state transitions, kinetics, and intermolecular forces.

Throughout the course, we will apply chemical principles to some important issues in materials science:

- solar energy conversion
- storing and releasing energy
- storing and processing information
- controlling nanoscale structures
- building functional devices



# Syllabus

## Instructor

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Simon Garcia  
Tomsich 108  
phone: 5077  
garcias@kenyon.edu

## Class Meetings

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Tomsich 103  
MWF  
9:10a–10:00a

## Required Materials

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- **Textbook:** S. Zumdahl, *Chemical Principles*, 6<sup>th</sup> edition
- **Model Kit:** HGS Molecular Structure Model Kit, type “C”
- **Calculator:** A basic scientific calculator:
  - should have the functions exp, ln,  $x^y$ , sin, and  $\sin^{-1}$
  - should be able to express numbers in scientific notation (e.g., “ $6.022 \times 10^{23}$ ”, or “6.022E+23”)
  - cannot access internet, voice, or text service
- **Binder or notebook:** Any device to keep lecture notes and assignments together. I recommend a 3-ring binder.

You should bring your calculator and binder/notebook to every class meeting, as well as to office hours.

## Additional Resources

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- R. Tilley, *Understanding Solids*, Wiley (2004).
- L. Smart and E. Moore, *Solid State Chemistry*, 1<sup>st</sup> edition, Chapman & Hall (1992).

These texts are available through Course Reserves at the library.

## General Objectives

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In addition to gaining specific kinds of knowledge, you will sharpen the following abilities as part of your liberal-arts education:

- Comprehend and speak the language of the discipline (in this case, chemistry and materials science)
- Apply and integrate multiple principles to novel or unfamiliar situations
- Use facts, observations, and theory to draw conclusions
- Write precise arguments to support conclusions

## Assignments

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Each week I will post an assignment at the Moodle site for this course. Each assignment contains a list of learning objectives, study questions, and exercises. I encourage you to work on the assignments with a study partner or group. Study the assignment before you attempt the weekly quiz.

Assignments will not specify readings from the primary text. One of your responsibilities is to determine which sections are relevant to the learning objectives. If you have trouble identifying relevant sections, please don't hesitate to ask about them in office hours. (Occasionally a topic will require you to read sources other than the primary text; in these cases, the assignment will indicate the appropriate readings.)

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## Weekly Quizzes

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Each quiz is due on Sunday at 10:00p, and will test basic understanding of the reading and review skills from Chem 121/122. Work on quizzes *alone*, so you will be prepared for these questions on exams. Use the quizzes to decide if you understand the basic concepts. Study the assigned reading first, and then take the quiz. If you have trouble with a few quiz questions, go back and review the relevant topics.

You should allot yourself 20 minutes for each quiz, although the quiz will be open for 1 hour. If you cannot finish within 20 minutes, find out why you had trouble, and review the relevant readings or exercises. Come to office hours if you want advice on what to study.

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## Weekly Checkpoints

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Every Friday you will take a “checkpoint,” which is a short, 15-minute simulated exam. Each checkpoint includes basic questions from the quiz, study questions, and assigned exercises. Because you have limited time for checkpoints and exams, you should practice doing the exercises until you can do them smoothly and rapidly. (Otherwise, you will waste time during the exam trying to remember how to do them.)

After each checkpoint, we will review the solutions in class. During this time, you can take notes on how to solve the problems. This will give you a chance to prepare for the same types of problems on exams. You will get full credit on each checkpoint for making an honest attempt at every question.

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## Exams

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Each exam is cumulative and will be 45 minutes long. Because of limited time, it is impossible to include every question encountered in class. For this reason, each exam will *sample* topics. Obviously, this means I cannot tell you which topics will be chosen, so please don't ask. 10% of each exam will include challenging, novel problems that test not just your knowledge, but your mental agility as well.

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## Challenge Problems

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Throughout the semester you will have a set of challenging, novel problems to work on. These problems delve into advanced issues in materials science, and you will likely find some of the content unfamiliar; however, you will discover that you know the chemical principles and methods to solve them. The hard part is to puzzle out their meaning, read articles, and experiment with different ways of solving the problems. You will have several weeks for each problem. You can submit early drafts to get feedback.

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## Final Exam

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The final exam is cumulative and will be 2 hours long. Because of limited time, it is impossible to include every question encountered in class. For this reason, the exam will *sample* topics from the weekly exams. Obviously, this means I cannot tell you which topics will be chosen, so please do not ask.

If you miss an exam or checkpoint during the semester, or score poorly on one, you may replace that score with your final exam score. In effect, the final will count more toward your total grade. You may apply this policy no more than two times. Please use this policy judiciously; it would be *extremely unwise* to rely on your final exam for, say, 40% of your grade!

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## Grading

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- 10 % Quizzes
  - 10 % Checkpoints
  - 50 % Exams
  - 10 % Challenge Problems
  - 20 % Final Exam
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## Course Policies

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**Pr-requisite:** Chem 121 or Chem 122. Lectures, quizzes, assignments, and exams will assume knowledge and skills from the fall semester course.

**Attendance.** Attendance at all class meetings is expected. Excessive, unexplained absences will result in expulsion from the course. Only the Dean of Students (not the instructor) can excuse an absence.

**Etiquette.** Upon arriving in class, please silence any devices you have. Maintain a respectful presence in class, and avoid disrupting or distracting fellow classmates once class begins. If you use an electronic device to take notes during class, please sit in the back of the classroom to avoid distracting other students. If you require frequent trips to the restroom, please seat yourself near the door so that you can exit unobtrusively. Finally, keep in mind at all times how your actions affect the people around you.

**Academic honesty.** Please read the College's statement on Academic Honesty in the *Course of Study*, pages 26–29. Pay special attention to the definition of plagiarism and to the examples of activities that violate the standards of academic honesty. I expect you to avoid plagiarism and cheating and to avoid even the mere appearance of possible plagiarism or cheating in all of your work.

**Collaboration.** Students are commonly confused about how to work with others without engaging in plagiarism. Here is the most common scenario in a science course: You are working on an assignment with your friend, and you are not sure about your answer to a question. You decide to compare your answer to her answer, and they are different. Comparing and discussing your answers is okay. You can even write down statements, diagrams, or calculations on paper to prove your point.

Suppose you resolve the disagreement, and your friend wants to change her answer. *At this point, stop discussing it and let her work by herself. In addition, do not offer anything you've written to her. Doing so makes you a party to plagiarism, and you can be held accountable for it.* Instead, let your friend work out the answer herself, without looking at anything you wrote.

The same principle applies to team projects. Your team can discuss answers with another, but you cannot offer any written or electronic material for the other team to look at when they prepare their answers.

**Planned, excused absence.** You are allowed a maximum of **two (2)** planned, excused absences in the entire course. Check all of your commitments for this semester and look for possible conflicts. The Dean of Students must excuse your absence and notify me in advance.

**Unplanned absence.** If you miss a class, quiz, exam, or assignment because of an *unexpected* event, such as illness, depression, bereavement, or the Imperius Curse, notify both me and the Dean of Students. You do not need to tell me the reason for your absence. I will verify the excused absence with the Dean, who will keep the reason confidential. Only the Dean of Students can excuse an absence.

**Late work.** I will not accept late work unless you have an excused absence. If you have an unexcused absence, I may accept your work if you forfeit 10 percentage points for every 24 hours that it is late.

**Disability services and accommodations.** If you have a learning disability or other disability that impacts your ability to learn, or think that you might have one, please schedule an appointment with Disability Services *as soon as possible*. Only the Coordinator of Disability Services is authorized to review your documentation and to recommend an *accommodation*. All discussions with the Coordinator are *confidential*. The Coordinator will inform me of the accommodation tailored to your situation. If your accommodation requires special testing conditions (*e.g.*, extra time, separate venue, extra breaks, assistive devices, assistive services), then you must inform me *at least two weeks in advance*. It is your responsibility to make arrangements for your accommodation.

**Changes to syllabus.** The policies articulated in this Syllabus are subject to change in response to unusual situations. You will be notified of any changes at least 48 hours before they go into effect.

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