PHY 123
Food, Fire, and Physics: The Science of Cooking

Instructor: Dr. Kevin B. Aptowicz
Spring 2020

Course Summary

This course will explore food and cooking from a physical science perspective. In particular, we will use principles in soft matter physics (e.g. phase diagram, intermolecular forces, diffusion, elasticity, viscosity) to gain a deeper understanding of food and cooking. Each week we will explore a different topic. This exploration will be both quantitative and qualitative as we try to unwrap the mysteries of cooking. It is my sincere hope that by the end of the semester your view of food and cooking will have dramatically evolved. Furthermore, I hope this represents the start of a lifelong journey where you think about the science of food and cooking with many culinary conquests ahead.

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1 Objectives

PHY123 is an approved science distributive course in the WCU General Education program. It is designed to help students meet the first three general education goals. Further details can be found in the subsections below:

1.1 Goal #1 - Communicate Effectively

Student Learning Outcome: Demonstrate comprehension of and ability to explain information and ideas accessed through reading

This course will involve lots of reading. Every lecture will have assigned reading which will serve as a backdrop for the lecture conversation as well as an additional medium to convey content. Your ability to comprehend the information and ideas covered in the reading will be assessed throughout the course. In particular, priot to every lecture, students will be asked to answer questions on the reading via a D2L quiz. In addition, all the exams in the course will include questions focused explicitly on the assigned reading. These reading quizzes and exam questions will serve as the primary form of assessment of reading comprehension. Equally important is the ability to explain information and ideas accessed through the reading. Each lecture, there will be two to three opportunities to explain ideas covered in the reading to your classmates. These opportunities will occur during "Concept Questions" when students attempt to reason out an answer to a stated question. The assessment of this learning outcome will occur on the first and second exam with an open-ended question all students must answer in written form.

1.2 Goal #2 - Think Critically and Analytically

Student Learning Outcome: Reach sound conclusions based on a logical analysis of evidence

Critical and analytically thinking will serve as a foundation for this course. During the semester, we will think about food and cooking on different length scales while we attempt to connect macroscopic phenomena to microscopic and molecular interactions. As we make these connections, we will develop simple models of food to understand their properties as well as develop mathematical expressions that will serve as predictive models. For example, what can we learn about diffusion by measuring the change in opacity of a piece of fish soaked in an acid solution? Is there a mathematical relationship that captures the relationship between the average distance diffused by the acid and the time passed? What general properties are involved in a diffusive process? How can we test if other processes are diffusive? This critical and analytical thinking will occur throughout the course including reading questions, in-class concept questions, problem set questions, and exam questions. Exam questions will serve as a primary form of assessment.

1.3 Goal #3 - Employ Quantitative Concepts and Mathematical Methods

Student Learning Outcome: Employ quantitative methods to examine a problem in the natural or physical world.

Over the course of the semester, we will have 10 different themes: 'Unit Conversion,' 'Building Blocks of Food,' 'Temperature, Heat, and Energy,' 'Phase Transitions,' 'Elasticity,' 'Dispersions and Diffusion,' 'Heat Transfer', 'Viscosity', 'Emulsions and Foams', and 'Fermentation & Enzymatic Reactions.' During the discussion of each theme, we will explore an equation that provides insight into that theme. These mathematical expressions will serve as a bridge between macroscopic phenomena we observe in the kitchen and the microscopic or molecular interactions at play. Students will utilize the mathematical expressions discussed in class to solve quantitative problems on problem sets and exams. Exam questions will serve as a primary form of assessment.

Student Learning Outcome: Apply the basic methods and thought processes of the scientific method for natural/physical science in a particular discipline.

The scientific method serves as the primary tool for knowledge creation in the physical sciences. In this course, we will explore the scientific method using various cooking demonstrations and experiments. Using cooking as a back-drop, we will discuss the process of generating a hypothesis, testing it, and then re-evaluating. A student's understanding of the scientific method will be tested during lecture with concept questions as well as on problem sets and exams. Exam questions will serve as a primary form of assessment.

1.4 Additional Unofficial Goals

In addition, I have some unofficial goals that have guided the construction of this course. They are:

- That students thoroughly enjoy the course and find it a fulfilling experience.

- That students end the course inspired to go into their own kitchen and experiment with different cooking techniques.
- That students continue to think about food and cooking from a scientific perspective for the rest of their lives. (I know, this is a bit ambitious.)

2 Course Information and Required Materials

Course:	PHY 123 - Food, Fire, and Physics: The Science of Cooking
Required Material:	**Textbook** - *On food and cooking: the science and lore of the kitchen* McGee, Harold, 2004. Publisher: Scribner **Calculator** - A stand-alone calculator that is not part of a cellphone or other internet-accessible personal electronic device. The calculator could be a simple scientific calculator that can calculate logarithmic and exponential functions (e.g. log(100) or $e^{\left(\frac{3}{5}\right)}$) and powers (e.g.$\sqrt{1024}$). These functions are all standard on scientific calculators. As an example, TI-30Xa (~$10) or TI-30X IIS (~$13) would do the trick. Again, you cannot use a cell phone.
Website:	Course materials are housed on D2L.
Lecture Location:	Schmucker Science Link, Room 151
Lecture Times:	Tuesday & Thursday 12:30 pm to 1:45 pm
Instructor:	Kevin B. Aptowicz (Dr. Aptowicz)
Office Location:	227 Schmucker Science Center South
Office Phone:	(610) 436-3010
Email:	kaptowicz@wcupa.edu
Office Hours:	Monday 8:30 am to 9:30 am Wednesday 8:30 am to 11:30 am Thursday 2:30 pm to 3:30 pm

3 Course Structure

How do we accomplish the objectives set forth in Section 1? It will require effort on both our parts. You will need to be a dedicated student with good time-management skills. In addition, you will need enough confidence to keep your chin up during rough stretches. I will need to develop pedagogically sound teaching tools that make efficient use of your valuable time and directly address those concepts or material that you find most challenging. This section gets at the heart of both of our roles and addresses how your time will be spent inside and outside the classroom.

3.1 The Calculation ... Student's Time on Task

The life of a student isn't easy. You have many demands on your time beyond this Gen Ed course. I need to be reasonable by not assigning more work than is humanly possible. This calculation is an attempt to due just that. In order to determine how much time a student can commit to PHY 123, I've made the following assumptions.

- The student (that's you!) spends a total of 45 hours a week on his or her college studies.
- The student course load is 15 credits.

Therefore, the total time a student is able to commit to this course per week is $\frac{45\text{ hours}}{15\text{ credits}} \times 3\,\text{credits} = 7.5\,\text{hrs}$. However, this is a Gen Ed course and thus should not be as intensive as a course in one's major. Thus, I'm designing the course assuming you will dedicate 7.5 hours a week to this course. These precious hours are allotted to the following tasks.

Table 1: Student time on task per week.

Task	Time
Actively participating in lecture	2.5 hrs
Reading	2 hrs
Wednesday Activity	1 hr
Weekly Reflection	1 hr
Recipe Response	30 mins
Packet Submission	30 mins

3.2 Recommended Weekly Schedule

It's all about time management! Learning physics' concepts and procedures takes time ... lots of time. You must practice applying the concepts and principles multiple times and work diligently at clearing up any misconceptions. If you create a regular weekly schedule for studying physics and take the course one step at a time, you will be shocked with the results. If you wait to the last minute and try to cram for an exam, the results will be disastrous. I'm expecting that you will spend 7 hours a week on this course. To spread out the work evenly over the week, I recommend the following schedule:

Day	Activity	Time
Sunday-Monday	D2L recall quiz Do reading	1 hour 1 hour
Tuesday	Attend class and work on weekly packet	1 hour and 15 minutes
Wednesday	Do reading Work on packet	1 hour 1 hour
Thursday	Attend class and work on weekly packet	1 hour and 15 minutes
Friday-Saturday	Submit packet PDF and do recipe reflection	45 minutes

3.3 Course Components

Here is a list of the different aspects of the course and the thinking behind each one.

Preclass Reading Yes, you must read form the required text before coming to class. By doing the preclass reading, I will be able to allot sufficient time on the more challenging concepts during lecture, which will payoff when you complete the problem sets. The required textbook is the acclaimed *On food and cooking: the science and lore of the kitchen* by Harold McGee. It is an excellent book as indicated by the many positive reviews on Amazon. I'm hoping you will not dread the reading assignments but instead look forward to them. You should be able to read a page of the text in less than 5 minutes, so I will make sure not to assign more than 12 pages per lecture (about an hour of reading).

Recall D2L Quiz There will be a weekly recall quiz on D2L which will provide an opportunity to recall the material from the previous week and strengthen your learning of it.

Active Lecture Lecture will not be a passive experience. There will be low stakes quizzes, small group discussions, experiments, and demonstrations. Please come ready to engage!

Exams There will be two exams during the semester. The exams will be a mix of free response and multiple choice. Completing the weekly study packets and thinking deeply about the material is an excellent way to prepare for the exams.

Catered Final Exam The final exam will occur during the last week of class. Students will take the exam in small groups while enjoying a catered lunch. Students will answer questions on the science of the food they are eating.

Receipe Book: The final project for this course will a recipe with a discussion of the science behind the recipe. Every student will be expected to submit one recipe. All the recipes will be compiled into a single PDF that will be shared with the class.

4 Grading Procedure

Grades! For some, this is the only section that matters. Enjoy.

4.1 Methods for Calculating Your Grade

The weights for the grades are provided below. Please note the importance of class participation (35%) and the recipe project (25%). These two elements make-up 60% of your grade! It is critical that sends attend class, participate, and do his/her weekly recipe reflections.

Weights

Class participation (PollEverywhere)	35%
Weekly recall quiz	10%
First Exam	10%
Second Exam	10%
Final Exam	10%
Recipe Project	25%

4.2 Letter Grade Assignment

I assign letter grades according to the following scale.

Numerical Grade	Letter Grade
93 - 100	A
90 - 92	A-
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
70 - 72	C-
67 - 69	D+
63 - 66	D
60 - 62	D-
below 59	F

5 Course Policies

Numerous course policies can be found below. If you need more details or have a question, stop by my office.

5.1 Academic & Personal Integrity

It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Undergraduate Handbook, the Undergraduate Catalog, the Ram's Eye View, and the University website at www.wcupa.edu.

5.2 Students with Disabilities

If you have a disability that requires accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about West Chester

University's Services for Students with Disabilities (OSSD), please visit them at 223 Lawrence Center. Their phone number is 610-436-2564, their fax number is 610-436-2600, their email address is ossd@wcupa.edu, and their website is at www.wcupa.edu/ussss/ossd. In an effort to assist students who either receive or may believe they are entitled to receive accommodations under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973, the University has appointed a student advocate to be a contact for students who have questions regarding the provision of their accommodations or their right to accommodations. The advocate will assist any student who may have questions regarding these rights. The Director for Equity and Compliance/Title IX Coordinator has been designated in this role. Students who need assistance with their rights to accommodations should contact them at 610-436-2433.

5.3 Excused Absences Policy

Students are advised to carefully read and comply with the excused absences policy, including absences for university-sanctioned events, contained in the WCU Undergraduate Catalog. In particular, please note that the "responsibility for meeting academic requirements rests with the student," that this policy does not excuse students from completing required academic work, and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

5.4 Reporting Incidents of Sexual Violence

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University protection of minors policy. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at the webpage for the Office of Diversity, Equity, and Inclusion at https://www.wcupa.edu/_admin/diversityEquityInclusion/aboutUs.aspx.

5.5 Emergency Preparedness

All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

5.6 Electronic Mail Policy

It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.

5.7 Screens Policy

It is critical that students remains engaged during class time and focused on the challenging concepts being discussed. Thus, devices (phones, tablets, laptops, etc.) use is strictly forbidden in class. Please do not leave cellphone on your laps or other locations where they might distract you. All cellphone must be packed away. For each infraction, the student's overall course grade may be reduced by a third of a letter grade. If an emergency situation arises and you need to check your cellphone, please excuse yourself from the class and check your cellphone in the hallway.

5.8 Missed Exam Policy

There are no make-up exams. If you miss an exam for an unexcused absence, you will receive a zero for that exam. If you miss an exam for an excused absence, please meet with me to discuss a possible solution.

5.9 Missed Problem Set Policy

Assigned problems will be graded every week. If you do not submit your work for the week, you will receive a zero. You can miss one problem set and it will not negatively impact your grade.

5.10 Attendance and Lateness Policy

You are expected to attend class. Missing class, being late to class, or leaving class early will reduce your participation grade.

5.11 Teaching Style

This course will rely heavily on lectures using the chalk boards as well as concept questions projected onto a screen. If you have problems seeing the chalk board or reading my handwriting, please move to the front of the class.

5.12 LGBTQA Ally

Based on West Chester University's commitment to diversity, I believe that everyone in my classroom should feel safe. I have completed the University's Lesbian, Gay, Bisexual, Transgender, Queer, Questioning Ally training. In becoming an ally I made the commitment to offer a safe space for all of my students, not just those who identify as LGBTQA. If you or someone you know would like to know more about this program, or needs to speak confidentially about issues of sexual orientation or gender identity, please feel free to see me during my office hours.

6 Schedule

Wow, you made it all the way to the schedule. Almost done. Here is the schedule of topics, exams, and special events for the class.

Week	Date	Day	Topic
0	Jan 21	Tu	Introduction / Course Design
0	Jan 23	Th	Introduction / Course Design
1	Jan 28	Tu	Unit Conversion
1	Jan 30	Th	Unit Conversion
2	Feb 4	Tu	Food Components
2	Feb 6	Th	Food Components
3	Feb 11	Tu	Temperature, Heat, Energy
3	Feb 13	Th	Temperature, Heat, Energy
4	Feb 18	Tu	Phase Transitions
4	Feb 20	Th	Phase Transitions
5	Feb 25	Tu	Elasticity
5	Feb 27	Th	Elasticity
	Mar 3	Tu	Review
	Mar 5	Th	EXAM #1
	Mar 10	Tu	SPRING BREAK
	Mar 12	Th	SPRING BREAK
6	Mar 17	Tu	Dispersions and Diffusion
6	Mar 19	Th	Disperisons and Diffusion
7	Mar 24	Tu	Heat Transfer
7	Mar 26	Th	Heat Transfer
8	Mar 30	Tu	Viscosity
8	Apr 2	Th	Viscosity
9	Apr 7	Tu	Emulsions and Foams
9	Apr 9	Th	Emulsions and Foams
10	Apr 14	Tu	Fermentation & Enzymatic Reactions
10	Apr 16	Th	Fermentation & Enzymatic Reactions
	Apr 21	Tu	Review
	Apr 23	Th	EXAM #2
	Apr 28	Tu	Catered Final Exam - Sykes Ballroom
	Apr 30	Th	Recipe Draft Review
	May 7	Th	Submit Recipe

7 Bibliography

The only required textbook for this course is:

- McGee, Harold. *On food and cooking: the science and lore of the kitchen.* Scribner, 2004.

This is a classic text that gives a general overview of the scientific concepts underlying cooking. More specific texts covering the scientific aspects of cooking, and the basic science, are listed below.

Other books on science and cooking:

1. Corriher, Shirley O. *Cookwise: the hows and whys of successful cooking.* William Morrow, 1997.
2. McGee, Harold. *The curious cook: More kitchen science and lore.* North Point Press, 1990.
3. This, Hervé, and Jody Gladding. *Kitchen mysteries: Revealing the science of cooking.* Columbia University Press, 2010.

4. This, Hervé. *The science of the oven.* Columbia University Press, 2009.

5. Beckett, Stephen T. *The science of chocolate.* Royal Society of Chemistry, 2008.

6. Clarke, Chris. *The science of ice cream.* Royal Society of Chemistry, 2012.

7. Ruhlman, Michael. *Ratio: The Simple Codes Behind the Craft of Everyday Cooking.* Scribner, 2009.

8. Barham, Peter. *The science of cooking.* Springer Verlag, 2001.

9. Potter, Jeff, and Michael Ruhlman. *Cooking for Geeks.* O'Reilly Media, Incorporated, 2010.

10. Crosby, Guy. *The science of good cooking : master 50 simple concepts to enjoy a lifetime of success in the kitchen.* Brookline, MA: America's Test Kitchen, 2012.

11. López-Alt, J. Kenji. *The Food Lab: Better Home Cooking Through Science.* W. W. Norton & Company, 2015.

Cookbooks written by chefs:

11. Achatz, Grant. *Alinea.* Achatz, 2008.

12. Blumenthal, Heston. *The fat duck cookbook.* Bloomsbury, 2009.

13. Adrià, Ferran, Albert Adrià, and Juli Soler. *A Day at elBulli.* Phaidon, 2010.

14. Andrés, José, and Richard Wolffe. *Made in Spain : Spanish dishes for the American kitchen.* New York: Clarkson Potter/Publishers, 2008.

15. Yosses, Bill, and Melissa Clark. *The Perfect Finish: Special Desserts for Every Occasion.* WW Norton, 2010.

16. Peternell, Cal. *Twelve Recipes.* William Morrow Cookbooks, 2014.

Scientific books:

16. Jones, Richard A. *Soft condensed matter.* Oxford New York: Oxford University Press, 2002.

17. Witten, T, and P. A. Pincus. *Structured fluids : polymers, colloids, surfactants.* Oxford New York: Oxford University Press, 2004.

18. Rubinstein, Michael, and Ralph H. Colby. *Polymer physics.* Oxford New York: Oxford University Press, 2003.

19. Hirst, Linda S. *Fundamentals of soft matter science.* Boca Raton: CRC Press, 2013.

20. Hamley, Ian W. *Introduction to soft matter : synthetic and biological self-assembling materials.* Chichester, England Hoboken, NJ: John Wiley & Sons, 2007.