

PHYSICS 0088: The Physics of Energy

Course Syllabus

Tuesday & Thursday 1:00-2:15PM in 104 Thaw Hall

Instructor Information

Instructor: Professor Andrew R. Zentner
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I am a member of the Department of Physics and Astronomy at the University of Pittsburgh. My research specialty is theoretical cosmology (cosmology is the study of the Universe).

Please do not hesitate to contact me with **any** questions or concerns about this course. Email is by far the best way to contact me. I want to work with my students to make this course interesting and **fun** and allow my students to learn. All too often, students wait until the end of the semester to express concerns, but by that time I cannot change anything. There is **no** question too insignificant and there is no need to wait until it is too late to express a concern. Of course, I have to abide by University and Department rules and I have to work within the Physics & Astronomy curriculum, so I cannot accommodate all requests, but my intention is to make this course as fun and productive as possible. I am looking forward to a great semester.

The University of Pittsburgh Canvas site will be the primary means of communication throughout the class. It is the responsibility of the student to check the Canvas site **often** for updates and assignments.

Office Hours

I will hold regular office hours from:

- Monday - 11AM to Noon in 314 Allen Hall
- Wednesday - 3PM-4PM via Zoom at <https://pitt.zoom.us/j/99776952574>

If you cannot make these times, please contact me and we can arrange to meet at another time. I maintain one in-person office hour and one Zoom office hour for maximum convenience.

If you need further help or would prefer to seek help from a tutor, the University of Pittsburgh Department of Physics and Astronomy maintains a Physics Resource Room in 312 Thaw Hall that is staffed by tutors between 9AM and 5PM on weekdays throughout the semester. Please take advantage of this service.

Course Description and Objectives

This is an introductory undergraduate course on energy. The course will describe both qualitatively and quantitatively energy use, energy generation, and sources of energy. In this course, we will explore potential energy sources and the limitations of potential energy sources for specific practical applications. The course will also describe many of the basic physical considerations related to climate change as this phenomenon has now become intimately connected with energy use. As of now, the course has a small enrollment, so I will be considering an alternative approach to the standard lecture format for this course. We will discuss this as a group at the first lecture.

The learning objectives of the course include the following.

1. Students will demonstrate understanding of the concepts of energy and power and the physical units of energy and power relevant to personal activity (e.g., kilowatts, kilowatt-hours, calories, Calories, Joules, horsepower, ...).
 2. Students will demonstrate qualitative understanding of entropy, engine efficiency, and the differences between “low-grade” energy (e.g., heat) and “high-grade” energy (e.g., electricity).
 3. Students will be able to make and interpret quantitative statements about personal (heating/cooling, travel, personal electronics, ...) and industrial energy use.
 4. Students will be able to make and interpret quantitative statements about several major sources of energy (coal, solar, geo-thermal, nuclear, wind, ...).
 5. Students will demonstrate quantitative understanding of environmental effects of greenhouse gases and qualitative understanding of feedbacks and noise in the climate system that complicate models of the climate system.
 6. Students will demonstrate understanding of the process of scientific inquiry, revision in science, and the practice of modern science including the peer-review process.
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Textbook

There is no required textbook. Indeed, this is a *unique* course that attempts to provide students with a basic, quantitative understanding of the physics of energy production,

energy use, and climate. As such, there exist no self-contained individual references on the topic and it would be a significant financial burden to require students to purchase multiple textbooks. I have prepared notes on all topics that we will cover and students will be able to study the subject using only the course notes and lecture slides prepared specifically for this course and available on the Canvas site for the course.

Nevertheless, I suggest optional readings for each topic as part of the course outline below. I have selected these readings from three sources:

1. *Sustainable Energy Without The Hot Air* by David J. C. MacKay and available for free at <https://www.withouthotair.com/> (Abbreviated as “SEWTHA” below.) I normally discourage the use of online physics resources because physics is widely misunderstood and so many online resources are not worth the electricity used to transmit them. However, this is an excellent book and Professor MacKay was a world-renowned scientist.
2. *Global Warming: Understanding the Forecast* by David Archer (Wiley, 2011). (Abbreviated as “GWUF” below.) This book is available in used paperback at a fairly reasonable cost.
3. *Physics for Future Presidents* by Richard Muller (Norton, 2009). (Abbreviated as “PFP” below.) This book is also available in used paperback for a fairly reasonable cost.
4. *The Physics of Energy* by Robert Jaffe and Washington Taylor (Cambridge 2018). This is an excellent book but uses calculus and assumes some previous knowledge of physics, so it is more advanced than a GenEd course. However, for those of you that may have physics and calculus experience, this may be a nice reference.

Email Me If You Have a Question

Prior to emailing me, please follow these steps.

1. Check the syllabus to see if your question is answered there.
2. Do not expect a reply at 2AM the night before an assignment is due or an exam.
3. Double-check the syllabus for the answer to your question.
4. Search the text of the syllabus for words related to your question.
5. **Always use the words “Physics 0088” in the subject line** and send mail to zentner@pitt.edu if you would like a prompt answer to your email. I **cannot**

guarantee that I will respond to emails that do not include these words in the subject line.

6. Check the syllabus again after writing the subject line.
 7. Compose your email.
 8. Check the syllabus.
 9. Remove abbreviations (such as “OMG” and ”IMHO”) from your email.
 10. Spell check your email.
 11. Check the syllabus.
 12. Check that the greeting in your email is something like “Dear Professor,” “Dr. Zentner,” “Professor Zentner,” or something similar and certainly not “Hey” or “Dude.”
 13. Send your email.
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Course Content and Weekly Outline

The weekly outline for this course will be as follows. (Suggest Readings Appear in Parenthesis)

- Week 1.** Introduction, the Scientific Method, and Critical Thinking (SEWTHA, Chapter 1).
- Week 2.** Numbers: They are powerful and should not be scary.
- Week 3.** Energy and basic units of measure (PFP, Chapter 1).
- Week 4.** Forms of Energy: Motion, Heat, Light, Chemical Energy, and More (SEWTHA, Chapter 1; PFP, Chapters 2 & 8)
- Week 5.** Worked Examples & Discussion of The Methodology of Science.
- Week 6.** Understanding Our Energy Usage (SEWTHA, Chapters 7, 9, & 11).
- Week 7.** Understanding Our Energy Usage (SEWTHA, Chapters 3 & 5; PFP Chapter 3);
First Exam, February 23
- Week 8.** Understanding Our Sources of Energy: Fossil Fuels & Nuclear (PFP Chapters 3-6; SEWTHA, Chapter 24)
- Week 9.** Understanding Our Sources of Energy: Renewable Energy (SEWTHA Chapters 4, 6, 8, 10, 16; PFP Chapters 8 & 9)

Week 10. Energy Storage (SEWTHA, Chapter 26)

Week 11. Worked Examples.

Week 12. Science and the Scientific Process: Research & Peer Review; **Second Exam, March 30.**

Week 13. The Solar System & The Sun (GWUF, Chapters 1 & 2)

Week 14. The Atmosphere and the Climate (GWUF, Chapters 3-6)

Week 15. Aggregation, Summary, & Review (GWUF, Chapters 8-10)

Exam Week. Cumulative Final Exam

Prerequisites

This course will be taught at the level of an General Education course in the Dietrich School of Arts and Sciences at the University of Pittsburgh. The only prerequisites are either a passing grade on the Freshman Placement Test in Algebra or any MATH class. These are required of all Dietrich School students.

Lecture

Class meetings will be a mixture of standard lectures, a large number of experiments and demonstrations, and cooperative work on order-of-magnitude physics problems. The suggested readings can help you to prepare for class and help you solidify your understanding of the material covered in class. Twenty percent of your final grade will be based upon your participation in lectures.

Homework and Reading Assignments

Homework assignments will be assigned via Canvas almost every week, beginning the second week of class and will often be accompanied by reading assignments. These homework assignments are designed to emphasize the points being discussed during lecture and help you to study for exams. These homework assignments are mandatory and will usually involve a short reading assignment and/or a short writing assignment.

Exams

There will be three exams in this course, including the final exam, which will be given during the official final exam week. Students must bring their ID cards to exams. The use

of books, notes or other written materials, computers, cellular phones, and all devices that can render documents, graphics, or connect to the internet are absolutely prohibited.

Each exam will cover approximately one-third of the course material. However, the material covered later in the course will often rely on the material covered earlier in the course, so it is difficult to do well on the later exams if you allow your understanding of the early material to deteriorate significantly.

Each exam be comprised of approximately 30 to 50 multiple-choice or true/false questions. The focus of this course will be on a qualitative understanding of astronomical subjects and sound reasoning in addressing scientific questions. Each exam will constitute 15% of your final course grade. The three exams taken together will constitute 45% of your final grade in this course. Make-up exams will only be given under extremely special circumstances, such as illness or University-approved travel, and will require a written confirmation from, for example, a medical doctor.

The exam dates are:

- **EXAM 1: Thursday, February 23, 2023**
- **EXAM 2: Thursday, March 30, 2023**
- **EXAM 3: Final Exam Week**

Course Grading Policies

The final grade will be computed from the different components of the course according to the following percentages.

- **20%** based on lecture participation as described above.
- **35%** based on homework.
- **45%** based on the sum of grades on three (3) exams. Each exam is worth 15% of your final grade individually.

The curve will be such that *at least* 40% of students will receive a letter grade of **B-** or better. The following grades will be **guaranteed**.

- > 90% of all available points earns a grade of A or better.
- > 80% of all available points earns a grade of B or better.
- > 70% of all available points earns a grade of C or better.
- > 60% of all available points earns a grade of D or better.

Due to the curve, you will often be able to earn these grades with percentages lower than those quoted above. The curve will **only be used to help** your grade and never to reduce your grade.

The Department of Physics and Astronomy

As students at the University of Pittsburgh, you have access to a Physics and Astronomy Department that is well-recognized and is performing world-class research. The Department of Physics and Astronomy wants you to feel welcome. If you are interested in further study of physics or astronomy please talk to your instructor or another faculty member. If you think you may be interested in getting involved in a career in Physics or Astronomy or in research in Physics or Astronomy, please feel free to contact the instructor or other faculty members.

Students with Disabilities

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services, 140 William Pitt Union, (412) 648-7890 (412) 383-7355 (TTY), as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Academic Integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

Code of Conduct

Communication is key to a productive learning environment, and we can maintain productive communication by exhibiting respect for one another. The success of the course for yourself and others depends on all of our commitment to behavior that demonstrates respect for differences, understanding towards others and a willingness to listen and learn. For these reasons, it is unacceptable to harass, discriminate against, or abuse anyone because of race, ethnicity, gender, disability, religious affiliation, sexual orientation, or age. If you witness or are subject to such harassment, please report it to the instructor or to

the Office of Diversity and Inclusion?.

Title IX

Legal text: “*No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance.*”

As a professor I am a mandatory reporter, and I am required to report violations of Title IX that I observe or am made aware of to the Title IX Office. Title IX violations include, but are not limited to, sexual harassment, sexual violence and verbal or sexual abuse. Within the classroom, behavior in violation might appear as: suggestive jokes or innuendos, inappropriate touching, and unwanted sexual behavior or advances, but my capacity and obligation to report does not end at the classroom.

Copyright Notice

The materials used in this course may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials. See Library of Congress Copyright Office and the University Copyright Policy.

Statement on Classroom Recording

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student’s own private use. The instructor may be more likely to grant permission if the student intends to autotune the lectures.

E-mail Communication Policy

Each student is issued a University e-mail address (username@pitt.edu) upon admittance. This e-mail address may be used by the University for official communication with students. Students are expected to read e-mail sent to this account on a regular basis. Failure to read and react to University communications in a timely manner does not absolve the student from knowing and complying with the content of the communications. The University provides an e-mail forwarding service that allows students to read their e-mail via other service providers (e.g., gmail, Hotmail, AOL, Yahoo). Students that choose to forward their e-mail from their pitt.edu address to another address do so at their own risk. If e-mail is lost as a result of forwarding, it does not absolve the student from responding

to official communications sent to their University e-mail address. To forward e-mail sent to your University account, go to <http://accounts.pitt.edu>, log into your account, click on Edit Forwarding Addresses, and follow the instructions on the page. Be sure to log out of your account when you have finished. (For the full E-mail Communication Policy, go to www.bc.pitt.edu/policies/policy/09/09-10-01.html.)