

# Physics 16: *Energy, Oil, & Global Warming*

## Fall 2022, Tue & Thu 10:15–11:45 in DRL-2C6

Professor Douglas J. Durian  
[djdurian@physics.upenn.edu](mailto:djdurian@physics.upenn.edu)

215-898-8147

Office: DRL-2N4

Office Hours: Tue 4-5pm, after class, appt.

TA: Michael Coyle

[coylemp@sas.upenn.edu](mailto:coylemp@sas.upenn.edu)

Office Hours:

### Materials:

- Primary source: Gary Bernstein's *Energy, Oil, & Global Warming* (available on Canvas). We will march through this text, in order, with our own emphasis.
- Secondary sources: David MacKay's *Sustainable Energy – Without the Hot Air*, (available for free at <http://www.withouthotair.com>) and Richard Muller's *Energy for Future Presidents* (paperback available for purchase; not required). Further readings as posted on Canvas throughout the semester.

### Goals:

- 1) Become a scientifically literate member of society, able to analyze individual and collective choices on quantitative bases backed up by experiments and calculations. Be able to recognize baseless claims and those that violate basic laws of physics.
- 2) Learn how energy is produced and consumed in the US and the world. The existence of post-agrarian society is made possible by, and desperately dependent upon, the use of large quantities of energy, primarily from fossil fuels. This has enormous political and environmental costs that will only become more severe. Our aim is to understand the methods, costs, risks, and potential of strategies to continue the industrial age through the current century.
- 3) Learn the science of energy. We will cover the laws of thermodynamics, which fundamentally limit the efficiency of energy usage. We will study light in order to understand energy use for lighting, but also solar energy and the greenhouse effect. We will examine the principal uses of energy (heating/AC, lighting, and transportation) and approaches to conservation. We will examine the cost, environmental impact, and resource sizes of the principal sources of energy (gas, oil, coal, nuclear, biofuels, hydroelectric, solar, wind power).

**Prerequisites:** Algebra and geometry. No previous study of physics is assumed.

**Format:** Lectures and discussion on Tuesdays. Active learning and midterm exams on Thursdays. All activities will be in-person; zoom will be used only if the instructor needs to isolate or is at a conference. In the beginning, we'll cover new material on Tuesdays, work problems together on Thursdays, and assign homework problems to be due the following Thursday. This will be interspersed with discussion of news articles and with two midterm exams. The course will culminate in a term paper on a course-related topic of choice (in lieu of a final exam), due at the end of our assigned final exam time (TBD).

**Masks:** Required in lectures and office hours; please cover both mouth and nose (Prof. Durian's wife is immune compromised). *Thank you!*

## Schedule and Assigned Readings:

<b>Week:</b>	<b>Topics:</b>	<b>Readings*:</b>
[1] Aug 30	What is energy?	GB1; DM2; RMIV
[2] Sep 6	Overview of US & worldwide energy budget	GB2; DM1,19; RMIIintro
[3] Sep 13	Heating, cooling, & insulation; money	GB3; DM7,21,E; RM7
[4] Sep 20	Thermodynamics	GB4
[5] Sep 27	Atoms & light; lighting	GB5; DM9
<b>Midterm #1 on Week 1-4 Material: Thu Sep 29</b>		
[6] Oct 4 (Fall Break Oct 6)	Climate change	GB6; DM31; RM3
[7] Oct 12	Fossil fuels	GB7; RM4,5,6
[8] Oct 18	Climate & fossils, cont'd	
[9] Oct 25	Hydropower, electricity	GB8; DM8; RM15
[10] Nov 1	Power plants & carbon capture	GB9; RM19
<b>Midterm #2 on Week 5-9 Material: Thu Nov 3</b>		
[11] Nov 8 (election day)	Wind & solar power	GB10,11; DM4,6,10,B,D; RM8,9
[12] Nov 15	Solar electricity, energy storage	GB12; DM26; RM10; DM18
[13] Nov 22 (Thanksgiving Nov 24)	Transportation	GB14; DM3,20,A; RM16,17
[14] Nov 29	Nuclear fission & fusion	GB15,16; DM24; RM11,12
[15] Dec 6	Catch up / wrap up	DM18,27-30; RMV

\*GB=Gary Bernstein (required), DM=David MacKay (rec'd), RM=Richard Muller (rec'd)

## Policies

- Homework: 25%
- Active Learning: 15%
- Midterm Exams: 2 x 20%
- Term Paper (in lieu of final exam): 20%

**Assignments:** Homework and active learning assignments are to be uploaded on time. Late papers will receive a 1% deduction per hour, automatically computed by Canvas. Corrections may be uploaded within one week after grading for up to ½ credit back.

**Midterms:** Exams will begin and end exactly on time. Arrive early, take alternate seating as possible, close all backpacks, purses, briefcases, etc., and place them under your seat so that the contents are not visible. Exams will be closed-book / closed-note; calculators and one 8.5x11in<sup>2</sup> formula sheet are allowed (both sides). Only clarifying questions will be answered; please do not ask for hints or verification of approach.

**Absences, Timing Issues, and Special Situations:** There will be no makeups for missed midterms; they will be given a zero unless you have a valid excuse and have discussed the matter with your instructor *in advance*. Valid excuses include serious illness or injury, the death of a close family member, university athletics, major religious holidays, etc. Examples of unacceptable excuses are: “I just didn't feel I was ready to take the exam;” “I had two other tests the same day;” “I had an interview;” or “I have airline tickets for that day.”

Students who require accommodation must notify the instructor and make suitable arrangements with OSD (<http://www.vpul.upenn.edu/lrc/sds>) well in advance.

**Exam Regrades:** Every effort will be taken to grade papers fairly; however, mistakes sometimes occur. If you believe a grading *mistake* has been made, write a description of the mistake as you see it, staple it to your paper, and give it to your instructor. Do not write on the original paper itself. Regrade requests will not be accepted more than *one week* after the return of the graded work. Note that *all* problems on a submitted exam may be regraded, not just the problem in question. If you believe you were penalized differently from another student who committed the same error, then you must include a copy of your friend's paper. Note that the grader's professionally-informed choice of policy for assigning partial credit is not a “grading mistake” subject to revision.

### ***Student Responsibilities:***

**All students must abide by Penn's Code of Academic Integrity** (see <http://www.upenn.edu/academicintegrity>). All work that you turn in must be your own. You are allowed to discuss your approaches to homework questions with other students or the TA/professor, but the work you turn in must be done entirely by you.

Please keep in mind that if you cannot figure out the homework questions without getting hints or help, then you will not do well on the exams. You are responsible for using homework to advance your knowledge and skills by doing it as independently as possible.

You are responsible for **checking the Grade Center on Canvas** to make sure that you have received proper credit for your work. All homework will be turned in via Canvas (you can type it up and print a PDF, or write it and send a legible scan/photo of your work as PDF). Graded work will be returned electronically too.

Importantly: you are responsible for your performance in this course! It is not *required* that you attend class, pay attention to boring lectures, read the textbook chapters in advance, etc. You are free to get a low grade! It is not the professor's or TA's responsibility to help you if you cannot apply yourself to the course or attempt last-minute cramming. The best way to do well is to be an engaged learner: not just attending, but actively thinking about the material during class and when studying.

***Finally, and most importantly: I want you to learn the material well, enjoy the course, and succeed. If you have questions about your performance, please contact me and we can discuss your progress.***