Honors Project
Physics 3410
Spring 2016

For your honors project, I'd like you to solve one or more problems from the Schroeder textbook, and write up the solution in the style of a short academic paper.

DEADLINES:
Monday, March 14th: tell me **which problem you want to write on.**
Monday, April 4th: A **First Draft** is due.
Monday, April 25th: **Final Draft** is due (in person or via email).

INSTRUCTIONS:
1) Below is a list of homework problems from the Schroeder textbook. Choose one from the list that sounds particularly interesting to you. Please read through the problem carefully, to see if it's something you think you can solve.

2) Solve the homework problem, correctly and completely. Check your method and your answers in every way you can think of, and consider whether the answer makes intuitive sense. You may consult with other people or textbooks (barring the textbook's solutions manual, assuming it's available), but the work should be your own.

3) Write up the solution as if it were a scientific paper, and this were a new discovery. It should include

a) an abstract,

b) an introduction that explains and motivates the problem. Why would someone care about this problem? How does it fit into a broader context?

c) Present your solution and results, including graphs. It should be more than just a series of algebraic steps; you should use words to motivate each major section of your calculation, and to explain simplifications and substitutions that aren't immediately obvious.

d) For a conclusion, you could discuss the ramifications of your result, or discuss next steps the research might progress. In any case, the paper should feel as if it has a proper ending, not leave me looking for a missing last page.

e) If you consulted with anyone, they should be mentioned in an Acknowledgements section. If you consulted any textbooks, websites, or papers, they should be mentioned in a References section.

If you don't have much exposure to scientific papers, you might take a look at the *American Journal of Physics*, which often has "toy problems" which don't require a lot of background knowledge.

You needn't worry about the specific format of your paper, so long as it is legible and logically structured. You can use LaTeX or Word or whatever you normally use to write papers, but it cannot be handwritten. (Note that your work will necessarily contain a fair amount of mathematics, so you'll need a word processor that can handle equations in

an elegant way.) If you need help with LaTeX I can give you a hand.

The paper should be written in your best English, with proper grammar, well-organized paragraphs, and at a level that is appropriate to your classmates. While length won't be a major consideration, it should be at least 4 pages long, including figures.

GRADING:

As an honors project, this will not affect your class grade. If I deem your final draft to be satisfactory, you will get honors credit for the course. I will be looking for the following:
1) Is the solution correct and complete?
2) Is the solution properly motivated with an introduction?
3) Is the paper well-organized and neat?
4) Is the paper well-written? If I have to struggle with your grammar and spelling, or if I can't figure out what you're saying, I'm going to give up.
I will be looking for all of these elements in your first draft, and let you know where I think your paper is lacking. If you make the corrections I request, then you will be in good shape.

PROBLEMS:

If an entry lists multiple problems, you would be expected to solve all parts. Problems marked with a * require some nontrivial use of a computing environment like a spreadsheet or Mathematica.

The virial expansion*	1.17
Effusion	1.22
The speed of sound	1.39
Convection in earth's atmosphere	1.4
Isothermal compressibilities	1.46
Negative heat capacities of stars	1.55, 3.4, 3.15
Black hole thermodynamics	2.42, 3.7, 7.53
Thermodynamics of rubber	3.34
Optimizing a Carnot engine for power	4.6
Stirling engine	4.21
Thermodynamics of muscle contraction	5.6, 5.7
Thermodynamics of magnetic systems *may require advanced E&M to solve*	5.17, 5.47

Aluminosilicate phases	5.29, 5.39
Ice engine paradox	5.33
Relative humidity and cloud formation *makes use of the result of problem 1.40*	5.42, 5.43, 5.44
Nucleation of cloud droplets	5.46
Energy fluctuations at fixed temperature	6.17, 6.18, 6.19
Anharmonic oscillators*	6.21
Paramagnetism for higher spins	6.22
Parahydrogen and orthohydrogen*	6.3
A model of thermal expansion	6.32
Cooperative adsorption in hemoglobin	7.2
Semiconductor impurities	7.5
An elementary model of fermions*	7.16, 7.27
White dwarf stars	7.23
Numerical treatment of a Fermi gas*	7.32
Statistics of pure semiconductors	7.33, 7.34
Paramagnetism in a Fermi gas	7.36
Spontaneous and stimulated emission	7.41
Formation of H atoms in the early universe*	7.47
The cosmic neutrino background	7.48
The greenhouse effect on Venus	7.56
Spin waves in a ferromagnet	7.64
Numerical calculations for a Bose gas*	7.69, 7.70
BEC in a harmonic trap	7.73
BEC in a harmonic trap, numerical treatment*	7.74
Quantum gases in the high-T limit	7.75