PHY 341: Thermodynamics (Independent Study)
Wisconsin Lutheran College
Course Syllabus Spring 2020

Introduction

What is the nature of heat? And what is its effect on various types of substances? In this course we will engage in a systematic study of the science of thermodynamics. In particular, we will aim at a deeper understanding of concepts such as temperature, energy, and entropy, and of the most common phases of matter: solids, liquids and gasses. This course is cross-listed with CHE 341. 3 lec.

Course instructor

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Grade components

Homework	80%	Final exam	20%

Grading scale

A	100-93%	C	74-70%
AB	92-88%	CD	66-62%
B	87-80%	D	61-54%
BC	79-75%	F	53-0%

Overview

The goal of this course is to understand thermodynamics—the science of heat that was developed largely during the 19th century by workers in France, Germany and England. With a few exceptions, lectures will be held on Wednesdays; Mondays and Fridays will be devoted to working out homework exercises in front of the class on the chalkboard. This is an exercise which is designed to build the students' ability and confidence in problem solving and oral presentation.

Homework exercises

As a general rule, you should write out your homework solutions as if you were explaining your work to a new student trying to learn thermodynamics. You may work on the homework assignments with other students, but each student must hand in his or her own hand-written homework problems. (Please refer to the Student Handbook for the College's policies on cheating and plagiarism. Suffice it to say here that you should never copy more than one or two words of text from a web page or any other source without specifically citing the source. When citing a web page, be sure to include the URL address and the date it was accessed.)

Selected Bibliography

Adkins, C.J., Equilibrium Thermodynamics, 3rd edition. Cambridge University Press, 1983. This is the required textbook for PHY 303. I've found this to be a comparatively clear and concise book and have used it several times when teaching this course at WLC.

Callen, H.B, Themodynamics and an introduction to Thermostatistics, 2nd edition. John Wiley and Sons, 1985. This is a challenging undergraduate textbook that takes a unique first-principles approach to the subject. It was used at UC Santa Barbara when I was there for a 2-semester course on thermodynamics and statistical physics.

Reid, C.E., Chemical Thermodynamics. McGraw-Hill, 1990. I have never used this book, but it was used for a short time by a chemistry professor at WLC; it emphasizes chemistry and is very concise, perhaps too concise for the beginner.

Cengel, Y.A and Boles, M.A., Thermodynamics: an engineering approach. McGraw-Hill, 1998. As can be deduced from the title, this book focuses on the aspects of thermodynamics which are applicable to engineering—particularly engine performance, refrigeration, and the fluid dynamics of jet engines.

Maxwell, J.C., Theory of Heat. Dover Publications, 2001. This book, first published by one of the founders of thermodynamics in 1888, is a wonderful read which carefully emphasizes the experimental aspect of the subject and takes a unique geometric approach to thermodynamic relations which completely sidesteps the use of partial derivatives.

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Carnot, S., Reflections on the Motive Power of Fire And other Papers on the Second Law of Thermody- namics. Dover Publications, 2005. This book, originally published in 1824 by Carnot himself, also contains a number of the most significant texts relating to the foundations of thermodynamics.

Kuehn, K.K., A Student's Guide through the Great Physics Texts, Volume IV: Heat, Atoms and Quanta. Springer, 2016. This textbook/anthology contains many of the original writings on thermodynamics by scientists such as Fourier, Carnot, Kelvin, Clausius, Maxwell, and Planck. It also contains study questions and exercises which draw out the main points of these challenging texts. Plus, the author is a very nice person.

Laidler, Meiser and Sanctuary, Physical Chemistry, 4th edition. Houghton Mifflin, 2003. This is a large tome designed for a 3-semester physical chemistry sequence involving thermodynamics, quantum mechanics and statistical physics. It has many problems but poor explanations. I've used it once and didn't like it, but it is certainly very comprehensive and worth a look.

Semester Schedule

Week 1 (Jan 20-24). No classes on Monday.		
	Key ideas	Introduction: temperature, heat, & thermodynamic equilibrium
	Assignment	1.1, 1.2
Week 2 (Jan 27-31)		
	Key ideas	The zeroth law: thermometry & temperature scales
	Assignment	2.1, 2.2, 2.3
Week 3 (Feb. 3-7)		
	Key ideas	The first law: work, energy, heat capacity, enthalpy & flow processes
	Assignment	3.1, 3.2, 3.3, 3.4
Week 4 (Feb. 10 -14)		
	Key ideas	The first law: work, energy, heat capacity, enthalpy & flow processes
	Assignment	3.5, 3.6, 3.7, 3.8
Week 5 (Feb. 17-21)		
	Key ideas	The second law: heat engines, and Carnot's cycle and absolute temperature
	Assignment	4.1, 4.4, 4.5, 4.9
Week 6 (Feb. 24-28)		
	Key ideas	The second law: heat engines, and Carnot's cycle and absolute temperature
	Assignment	5.2, 5.4, 5.5 5.6
Week 7 (Mar. 2-6)		
	Key ideas	The second law: heat engines, and Carnot's cycle and absolute temperature
	Assignment	5.8, 5.9, 5.10
Week 8 (Mar. 9-13) Spring Break. No classes.		
Week 9 (Mar. 16-20)		

	Key ideas	Thermodynamic potentials: Legendre transformations & Maxwell's relations
	Assignment	7.1, 7.2, 7.3, 7.5
Week 10 (Mar. 23-27)		
	Key ideas	Applications to simple systems: specific heat capacities, compressibility, permittivity, Young moduli, magnetic susceptibility, ideal and real gases, electromotive force, surface tension, thermo-mechanical and magneto-caloric effects, thermal radiation.
	Assignment	8.1, 8.2, 8.7
Week 11 (Mar. 30 - Apr. 3)		
	Key ideas	Applications to simple systems: specific heat capacities, compressibility, permittivity, Young moduli, magnetic susceptibility, ideal and real gases, electromotive force, surface tension, thermo-mechanical and magneto-caloric effects, thermal radiation.
	Assignment	8.18, 8.21, 8.23, 8.29
Week 12 (Apr. 6 - 10) Easter break; no classes Thursday or Friday		
	Key ideas	Applications to some irreversible changes: Joule expansion and gas liquefaction
	Assignment	9.1, 9.2, 9.3, 9.5
Week 13 (Apr. 13 - 17) Easter break; no classes on Monday		
	Key ideas	
	Assignment	
Week 14 (Apr. 20 - 24)		
	Key ideas	Change of phase: equilibrium, Clausius-Clapeyron eqn., Gibbs function, critical points, higher order phase changes, superconductivity and superfluidity
	Assignment	10.1, 10.3, 10.7
Week 15 (Apr. 27 - May 1)		
	Key ideas	Change of phase: equilibrium, Clausius-Clapeyron eqn., Gibbs function, critical points, higher order phase changes, superconductivity and superfluidity
	Assignment	10.9, 10.10, 10.11
Week 16 (May 4 - 8)		
	Key ideas	Systems of several components: mixing, partial pressure, chemical potential, reaction equilibrium, osmotic pressure, solubility gaps,
	Assignment	11.1, 11.4, 11.5, 11.6
Week 17 (May11 - 15). Final exams.		