## PHYSICS 3610: THERMODYNAMICS

Instructor: Dr. William Robertson

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Office Hours: 9:30 am - 2:00 pm Monday/Wednesday, 11:30 am - 1:30 pm Tuesday/ Thursday

**Objective:** To provide an introduction to thermodynamics. The course divides into an initial section that covers the essentials of thermodynamics from the applied engineering perspective and a second section that covers the topic incorporating the more fundamental statistical mechanics approach.

Texts: An Introduction to Thermal Physics by Daniel V. Schroeder

Fundamentals of Physics by Halliday, Resnick, and Walker

**Grading:** The course grade will be determined by a combination of homework, two in class tests, and a final exam.

Test 1 25% Test 2 25% Final Exam 25% Homework 25%

To pass the course it is necessary to obtain a grade of C in Test 1 which covers the engineering level Thermodynamics at the level of Halliday and Resnick.

**Accommodations:** Students with disabilities that may require assistance or accommodation, or if you have questions about accommodations for testing, note takers, readers, etc. you should see me <u>in the first week or two of classes</u>. Students may also contact the Office of Disabled

Student Services (898-2738) with questions.

**Note:** It is the policy of the Department of Physics & Astronomy that no drops will be approved after the deadline posted in the university's course Schedule Book (after 8th week). The final date for dropping a course with a W for this semester is October 29.

**Midterm Grade Reports**: The University now requires us to submit an estimated grade during the semester. The midterm grade is my **best** estimate of your progress. It's not a promise or a threat, it's my honest estimate of where you stand at that point. Your final grade may be quite different.

## Do you have a lottery scholarship?

To retain Tennessee Education Lottery Scholarship eligibility, you must earn a cumulative TELS GPA of 2.75 after 24 and 48 attempted hours and a cumulative TELS GPA of 3.0 thereafter. You may qualify with a 2.75 cumulative GPA after 72 attempted hours (and subsequent semesters), if you are enrolled full-time and maintain a semester GPA of at least 3.0. A grade of C, D, F, or I in this class may negatively impact TELS eligibility. Dropping a class after 14 days may also impact eligibility; if you withdraw from this class and it results in an enrollment status of less than full time, you may lose eligibility for your lottery scholarship. Lottery recipients are eligible to receive the scholarship for a maximum of five years from the date of initial enrollment, or until a bachelor degree is earned. For additional Lottery rules, please refer to your Lottery Statement of Understanding form, review lottery requirements on the web at

http://scholarships.web.mtsu.edu/telsconteligibility.htm, or contact the Financial Aid Office at 898-2830.

TAUR 27	Class	Date	Topics	Homework	Due
Law of Thermodynamics; Thermal Expansion   Temperature and Heat; Heat Capacity and Specific Heat; Thermal Conductivity   Say, 41   CH 18 #23, 30, 32, 33, 38, 39, 41   Thermal Conductivity   Say, 41   CH 18 #23, 30, 32, 33, 38, 39, 41   The Internal Conductivity   Say, 41   CH 18 #31, 57; 42, 43, 49; CH 19 #5, 12, 14   CH 18 #64 Gas; Macroscopic Description; Properties and Processes; State Variables; First Law of Thermodynamics; Ideal Gas: Microscopic Description; Properties and Processes of an Ideal Gas; Equipartition of Energy   S1, 56, 57   Say, 56, 57   Say, 56, 57   CH 20 #21, 26, 27, 40, 51   R Sep 12   Entropy and the Second Law of Thermodynamics   CH 20 #21, 26, 27, 40, 51   R Sep 19   R Sep 12   Entropy and the Second Law of Thermodynamics   CH 20 #4, 57, 7, 8, 14, 20, 27   T Sep 17   An Overview of Introductory Thermodynamics   CH 20 #4, 57, 7, 8, 14, 20, 27   T Sep 17   An Overview of Introductory Thermodynamics   CH 2 #4, 57, 7, 8, 14, 20, 27   T Sep 19   Test 1: Introductory Thermodynamics   CH 2 #4 (only monatomic and diatomic gases), 45, 51, 57   CH 20 #4, 57, 7, 8, 14, 20, 27   T Sep 24   Heat Capacity, Latent Heat, and Enthalpy   CH 2 #1, 2   CH 2 #1, 2   R Oct 10   CH 2 #1, 2 #1, 2   R Oct 10   CH 2 #1, 2 #1, 2   R Oct 10   CH 2 #1, 2 #1, 2   R Oct 10   CH 2 #1, 2 #1, 2   R Oct 10   CH 2 #1, 3 #1, 4, 17, 23   R Oct 10   CH 2 #1, 3 #1, 4, 17, 23   R Oct 17   CH 2 #1, 3 #1, 4, 17, 23   R Oct 17   CH 2 #1, 3 #1, 4, 17, 23   R Oct 17   CH 2 #1, 3 #1, 4, 17, 24   R Oct 10   CH 3 #27, 28, 31, 33, 36, 37   R Oct 17   CH 2 #1, 3 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4 #1, 4					Date
Law of Thermodynamics; Thermal Expansion	1	T Aug 27	Intro to the Course; Temperature Scales and the Zeroth	CH 18 # 6, 14, 15, 17, 19	R Sep 5
Thermal Conductivity   39, 41   Total   Feat and Work; PV Diagrams; Thermodynamics   Processes; State Variables; First Law of Thermodynamics; CH 18 #51, 57; 42, 43, 49; CH 19 #5, 12, 14   R Sep 12   The deal Gas: Macroscopic Description   Properties and   Processes of an Ideal Gas: Macroscopic Description   Properties and   Processes of an Ideal Gas: Equipartition of Energy   51, 56, 57   R Sep 12   Sep 10   The Carnot Cycle: Heat Engines and Refrigerators   CH 20 #21, 26, 27, 40, 51   R Sep 19   Entropy and the Second Law of Thermodynamics   CH 20 #4, 57, 7, 8, 14, 20, 27   R Sep 19   Total   Einstein Solids and Macrostate Probabilities   CH 2 #13, 14, 17, 23   R Oct 10   Total   Einstein Solids and Macrostate Probabilities   CH 2 #13, 14, 17, 23   R Oct 17   Total   Entropy and the Second Law   CH 2 #27, 28, 31, 33, 36, 37   R Oct 17   Total   Entropy and the Second Law   CH 2 #27, 28, 31, 33, 36, 37   R Oct 17   Total   Entropy Ent		Ü			•
T Sep 3	2	R Aug 29			R Sep 5
Processes; State Variables; First Law of Thermodynamics: Ideal Gas: Macroscopic Description; Properties and Processes of an Ideal Gas: Equipartition of Energy   S1, 56, 57			·		
Ideal Gas: Macroscopic Description	3	T Sep 3	<u> </u>		R Sep 12
R Sep 5			<u>-</u>	CH 19 #5, 12, 14	
Processes of an Ideal Gas; Equipartition of Energy   51, 56, 57   T Sep 10   The Carnot Cycle: Heat Engines and Refrigerators   CH 20 #21, 26, 27, 40, 51   R Sep19	4	R Sep 5	· · · · · · · · · · · · · · · · · · ·	CH 19 #24, 25, 41, 46, 49,	R Sep 12
R Sep 12			Processes of an Ideal Gas; Equipartition of Energy	51, 56, 57	'
7   T Sep 17	5	T Sep 10	The Carnot Cycle: Heat Engines and Refrigerators	CH 20 #21, 26, 27, 40, 51	R Sep19
T Sep 17 An Overview of Introductory Thermodynamics  R Sep 19 Test 1: Introductory Thermodynamics  T Sep 24 Heat Capacity, Latent Heat, and Enthalpy  CH 1 #44 (only monatomic and diatomic gases), 45, 51, 57  Tot 10 R Sep 26 Heat Capacity, Latent Heat, and Enthalpy  CH 2 #1,2 R Oct 10  T Oct 1 Einstein Solids and Macrostate Probabilities  CH 2 #5(b), 5(d), 6, 9 R Oct 10  T Oct 3 (Very) Large System Multiplicities  CH 2 #13, 14, 17, 23 R Oct 17  T Oct 8 Entropy and the Second Law  CH 2 #27, 28, 31, 33, 36, 37 R Oct 17  T Oct 15 FALL BREAK  T Oct 17 Paramagnetism  CH 3 #27, 28, 29, 31, 32, 33 R Oct 31  T Oct 22 Mechanical Equilibrium  CH 3 #27, 28, 29, 31, 32, 33 R Oct 31  R Oct 24 Diffusive Equilibrium and the Chemical Potential  CH 3 #36, 37 T Nov 5  R Oct 31 Helmholtz Free Energy and Gibbs Free Energy  T Nov 5 Test 2: Schoeder Chs 1-4  R Nov 14 The van der Waals Equation of State  CH 5 #48, 49, 50 R Nov 21  Average Values and Equipartition  CH 6 #2, 5, 10 R Nov 28  R Nov 28 The Partition Function and Free Energy and the Ideal Gas  CH 7 #14  CH 7 #14  CH 6 #48  CH 6 #48  CH 6 #48  CH 7 #14	6	R Sep 12	Entropy and the Second Law of Thermodynamics	CH 20 #4, 57, 7, 8, 14, 20,	R Sep19
8         R Sep 19         Test 1: Introductory Thermodynamics           9         T Sep 24         Heat Capacity, Latent Heat, and Enthalpy         CH 1 #44 (only monatomic and diatomic gases), 45, 51, 57           10         R Sep 26         Heat Capacity, Latent Heat, and Enthalpy         CH 2 #1,2         R Oct 10           11         T Oct 1         Einstein Solids and Macrostate Probabilities         CH 2 #15, (b), 5(d), 6, 9         R Oct 10           12         R Oct 3         (Very) Large System Multiplicities         CH 2 #13, 14, 17, 23         R Oct 17           13         T Oct 8         Entropy and the Second Law         CH 2 #27, 28, 31, 33, 36, 37         R Oct 17           14         R Oct 10         Entropy, Temperature, and Heat         CH 3 #5, 8, 10, 11         R Oct 24           15         T Oct 15         FALL BREAK         CH 3 #21, 23, 24         R Oct 31           16         R Oct 17         Paramagnetism         CH 3 #21, 23, 24         R Oct 31           17         T Oct 22         Mechanical Equilibrium         CH 3 #27, 28, 29, 31, 32, 33         R Oct 31           18         R Oct 24         Diffusive Equilibrium and the Chemical Potential         CH 3 #36, 37         T Nov 5           20         R Oct 29         Real Heat Engines         CH 4 #18, 22, 36         T Nov 5				27	
T Sep 24 Heat Capacity, Latent Heat, and Enthalpy CH 1 #44 (only monatomic and diatomic gases), 45, 51, 57  Total R Sep 26 Heat Capacity, Latent Heat, and Enthalpy CH 2 #1,2 R Oct 10  T Oct 1 Einstein Solids and Macrostate Probabilities CH 2 #5(b), 5(d), 6, 9 R Oct 10  R Oct 3 (Very) Large System Multiplicities CH 2 #13, 14, 17, 23 R Oct 17  T Oct 8 Entropy and the Second Law CH 2 #27, 28, 31, 33, 36, 37 R Oct 17  T Oct 15 FALL BREAK  T Oct 15 FALL BREAK  R Oct 17 Paramagnetism CH 3 #27, 28, 29, 31, 32, 33 R Oct 31  T Oct 22 Mechanical Equilibrium and the Chemical Potential CH 3 #36, 37 T Nov 5  T Oct 29 Real Heat Engines CH 4 #18, 22, 36 T Nov 5  T Nov 5 Test 2: Schoeder Chs 1-4  R Nov 1 The wan der Waals Equation of State CH 5 #48, 49, 50 R Nov 21  T Nov 19 The Boltzmann Factor and the Partition Function CH 6 #32, 32, 32 (a,b only)  T Nov 26 The Maxwell Distribution and Free Energy and the Ideal Gas  R Nov 28 The Partition Function CH 6 #48  29 T Dec 3 Quantum Statistics: Bosons and Fermions CH 7 #14  CH 1 #44 (only monatomic and diatomic gases), 45, 51, 57  R Oct 10  CH 2 #11,2 R Oct 10  CH 2 #1,2 R Not 10  CH 2 #1,2 R Not 10  CH 3 #27, 28, 32, 31, 33, 36, 37  R Oct 17  R Oct 17  R Oct 17  R Oct 17  R Oct 24  R Not 24 Diffusive Equilibrium and the Chemical Potential CH 3 #27, 28, 29, 31, 32, 33  R Oct 31  T Nov 5  T Nov 10  R Nov 21  CH 6 #33, 34, 35, 39  R Dec 3  R Nov 28  R Nov 28  T Dec 3  Quantum Statistics: Bosons and Fermions CH 6 #48  CH 7 #14	7	T Sep 17	An Overview of Introductory Thermodynamics		
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11         T Oct 1         Einstein Solids and Macrostate Probabilities         CH 2 #5(b), 5(d), 6, 9         R Oct 10           12         R Oct 3         (Very) Large System Multiplicities         CH 2 #13, 14, 17, 23         R Oct 17           13         T Oct 8         Entropy and the Second Law         CH 2 #27, 28, 31, 33, 36, 37         R Oct 17           14         R Oct 10         Entropy, Temperature, and Heat         CH 3 #5, 8, 10, 11         R Oct 24           15         T Oct 15         FALL BREAK         CH 3 #21, 23, 24         R Oct 31           16         R Oct 17         Paramagnetism         CH 3 #21, 23, 24         R Oct 31           17         T Oct 22         Mechanical Equilibrium         CH 3 #27, 28, 29, 31, 32, 33         R Oct 31           18         R Oct 24         Diffusive Equilibrium and the Chemical Potential         CH 3 #36, 37         T Nov 5           19         T Oct 29         Real Heat Engines         CH 4 #18, 22, 36         T Nov 5           20         R Oct 31         Helmholtz Free Energy and Gibbs Free Energy         CH 5 #2, 5         R Nov 14           21         T Nov 5         Test 2: Schoeder Chs 1-4         CH 5 #2, 5         R Nov 24           22         R Nov 12         Thermodynamic Potentials and Phase Transitions         CH 5 #10, 11, 1					
12         R Oct 3         (Very) Large System Multiplicities         CH 2 #13, 14, 17, 23         R Oct 17           13         T Oct 8         Entropy and the Second Law         CH 2 #27, 28, 31, 33, 36, 37         R Oct 17           14         R Oct 10         Entropy, Temperature, and Heat         CH 3 #5, 8, 10, 11         R Oct 24           15         T Oct 15         FALL BREAK         CH 3 #21, 23, 24         R Oct 31           16         R Oct 17         Paramagnetism         CH 3 #21, 23, 24         R Oct 31           17         T Oct 22         Mechanical Equilibrium         CH 3 #27, 28, 29, 31, 32, 33         R Oct 31           18         R Oct 24         Diffusive Equilibrium and the Chemical Potential         CH 3 #36, 37         T Nov 5           19         T Oct 29         Real Heat Engines         CH 4 #18, 22, 36         T Nov 5           20         R Oct 31         Helmholtz Free Energy and Gibbs Free Energy         Helmholtz Free Energy and Gibbs Free Energy           21         T Nov 5         Test 2: Schoeder Chs 1-4         CH 5 #2, 5         R Nov 14           23         T Nov 12         Thermodynamic Potentials and Phase Transitions         CH 5 #10, 11, 12, 21, 28, 32         R Nov 21           24         R Nov 14         The van der Waals Equation of State         CH 5 #48,		•			
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T Nov 19 The Boltzmann Factor and the Partition Function CH 6 #2, 5, 10 R Nov 28  R Nov 21 Average Values and Equipartition CH 6 #17, 18, 23, 32 (a,b only)  T Nov 26 The Maxwell Distribution Function CH 6 #33, 34, 35, 39 R Dec 3  R Nov 28 The Partition Function and Free Energy and the Ideal Gas CH 6 #48  T Dec 3 Quantum Statistics: Bosons and Fermions CH 7 #14		R Nov 14	The van der Waals Equation of State	CH 5 #48, 49, 50	
26R Nov 21Average Values and EquipartitionCH 6 #17, 18, 23, 32 (a,b only)R Nov 2827T Nov 26The Maxwell Distribution FunctionCH 6 #33, 34, 35, 39R Dec 328R Nov 28The Partition Function and Free Energy and the Ideal GasCH 6 #4829T Dec 3Quantum Statistics: Bosons and FermionsCH 7 #1430R Dec 5STUDY DAY			The Boltzmann Factor and the Partition Function	CH 6 #2, 5, 10	
only)  T Nov 26 The Maxwell Distribution Function CH 6 #33, 34, 35, 39 R Dec 3  R Nov 28 The Partition Function and Free Energy and the Ideal Gas CH 6 #48  T Dec 3 Quantum Statistics: Bosons and Fermions CH 7 #14  R Dec 5 STUDY DAY			Average Values and Equipartition	CH 6 #17, 18, 23, 32 (a,b	
28 R Nov 28 The Partition Function and Free Energy and the Ideal Gas CH 6 #48  29 T Dec 3 Quantum Statistics: Bosons and Fermions CH 7 #14  30 R Dec 5 STUDY DAY				only)	
29 T Dec 3 Quantum Statistics: Bosons and Fermions CH 7 #14  30 R Dec 5 STUDY DAY	27	T Nov 26	The Maxwell Distribution Function	CH 6 #33, 34, 35, 39	R Dec 3
30 R Dec 5 STUDY DAY	28	R Nov 28	The Partition Function and Free Energy and the Ideal Gas	CH 6 #48	
	29	T Dec 3	Quantum Statistics: Bosons and Fermions	CH 7 #14	
Th Dec 12 Final Exam 1:00 pm- 3:00 pm	30	R Dec 5	STUDY DAY		
		Th Dec 12	Final Exam 1:00 pm- 3:00 pm		