

Syllabus

INDIANA WESLEYAN UNIVERSITY
PHYS-506: Modern Physics – Online Asynchronous
Summer II – 6/28/22-8/21/22
Written by: Victor Parkinson, PhD
Instructor: TBD
Contact: John Birch, PhD john.birch@indwes.edu

Course Description

This course develops the laws of thermodynamics from macroscopic observations and then demonstrates how they arise from the statistical, collective behavior of atoms and molecules. The statistical development encompasses classical systems (kinetic theory, transport phenomena, and ensemble theory) and quantum systems (systems of bosons and fermions). Prerequisites: a bachelor's degree with a physics major or be state certified (in any state) to teach Physics at a secondary school level and PHYS-501 or equivalent.

Note: This course is designed for those seeking the credentials required by many regional accrediting bodies in order to be able to teach advanced placement, concurrent early college, and community college physics courses.

Credit Hours: 3

Prerequisite Courses: PHYS-501 or equivalent (recommend PHYS-502, PHYS-503 or equivalents)

Prerequisite Skills and Knowledge: Prerequisites: a bachelor's degree with a physics major or state certification (in any state) to teach physics at a secondary school level.

Course Outcomes

Upon successful completion of this course, you should be able to:

1. Formulate a biblical worldview utilizing the attained scientific knowledge in physics.
2. Solve problems in thermal and statistical physics by applying the mathematical formulation to observable systems.
3. Apply the equivalence of the different expressions of entropy.
4. Derive the macroscopic behavior and the laws of thermodynamics from an atomic basis by applying mathematical and statistical reasoning to collections of particles.
5. Explain boson and fermion systems using quantum statistical mechanics.
6. Model the relationship between mathematical results and observable behavior by utilizing computer algebra applications (e.g. Mathematica, Maple).

Course Textbook

Pathria, R. K., & Beale, P.D. (2011) *Statistical mechanics*, (3rd ed.). Academic Press.

Course Technology

Each student will need to purchase a temporary site license for Mathematica Online. This can be arranged through Indiana Wesleyan.

For submitting solutions to assigned problems from the text, students may use Microsoft Equation Editor, LaTeX, or another text/equation editor and submit a PDF or scans of work written on paper.

IWU Diversity Statement

IWU, in covenant with God's reconciling work and in accordance with the biblical principles of our historic Wesleyan tradition, commits to build a community that reflects Kingdom diversity.

We will foster an intentional environment for living, teaching, and learning, which exhibits honor, respect, and dignity. Acknowledging visible or invisible differences, our community authentically values each member's earthly and eternal worth. We refute ignorance and isolation and embrace deliberate and courageous engagement that exhibits Christ's commandment to love all humankind. (2016)

Grading Scale

NOTE: In graduate-level courses, a grade of C- or below will require the course to be repeated.

Grade	Quality Points Per Credit	Percentage	Score
A	4.0	95%–100%	950–1000
A-	3.7	92%–94.9%	920–949
B+	3.3	89%–91.9%	890–919
B	3.0	85%–88.9%	850–889
B-	2.7	82%–84.9%	820–849
C+	2.3	79%–81.9%	790–819
C	2.0	75%–78.9%	750–789

C-	1.7	72%–74.9%	720–749
D+	1.3	69%–71.9%	690–719
D	1.0	65%–68.9%	650–689
F	0.0	0%–64.9%	0–649

Grading Policies

Your grading policy for your course is dependent on your school and program. Your grading policies can be found in the [IWU Catalog](#).

Letter Grade Equivalencies

NOTE: In graduate-level courses, a grade of C- or below will require the course to be repeated.

Grade	Description of Work
A	Clearly stands out as excellent performance. Has unusually sharp insights into material and initiates thoughtful questions. Sees many sides of an issue. Articulates well and writes logically and clearly. Integrates ideas previously learned from this and other disciplines. Anticipates next steps in progression of ideas. Example "A" work should be of such nature that it could be put on reserve for all cohort members to review and emulate. The "A" cohort member is, in fact, an example for others to follow.
B	Demonstrates a solid comprehension of the subject matter and always accomplishes all course requirements. Serves as an active participant and listener. Communicates orally and in writing at an acceptable level for the degree program. Work shows intuition and creativity. Example "B" work indicates good quality of performance and is given in recognition for solid work; a "B" should be considered a good grade and awarded to those who submit assignments of quality less than the exemplary work described above.
C	Quality and quantity of work in and out of class are average. Has marginal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at least minimally.
D	Quality and quantity of work are below average. Has minimal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at below-acceptable levels.

F	Quality and quantity of work are unacceptable and do not qualify the student to progress to a more advanced level of work.
----------	----------------------------------------------------------------------------------------------------------------------------

Course Module Summary

Module	Optional Devotion*	Discussion*	Dropbox*	Total Points per Module
Module One	1/0	1/20	1/70	90
Module Two	—	1/30	2/110	140
Module Three	1/0	1/20	2/110	130
Module Four	1/0	1/20	2/110	130
Module Five	1/0	1/20	1/70	90
Module Six	1/0	1/20	2/120	140
Module Seven	—	1/30	2/110	140
Module Eight	1/0	1/20	2/120	140
End-of-Course Survey				10 extra credit
TOTAL	6/0	8/180	14/820	1000

* Number of Activities/Sum Point Totals

Module One Outline

Title	Type	Due Dates	Time	Points
-------	------	-----------	------	--------

1.1 Faith and James Joule	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
1.2 Reading	Reading	Complete prior to assignments.	1:30 hours	0
1.3 Entropy	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
1.4 Thermodynamics Application Problems	Dropbox	Due by the end of the module.	5 hours	70
Totals			9 hours*	90

* These times are only estimates. Actual assignment completion times will vary.

Module Two Outline

Title	Type	Due Dates	Time	Points
2.1 Reading	Reading	Complete prior to assignments.	1 hour	0
2.2 Faith and James Joule	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	30
2.3 Micro-Canonical Application Problems	Dropbox	Due by the end of the module.	5 hours	70
2.4 Modeling an Ensemble	Dropbox	Due by the end of the module.	3 hours	40
Totals			11 hours*	140

* These times are only estimates. Actual assignment completion times will vary.

Module Three Outline

Title	Type	Due Dates	Time	Points
3.1 Francis Bacon on Physics and Faith	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
3.2 Reading	Reading	Complete prior to assignments.	3:30 hours	0
3.3 Ensemble Theory	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
3.4 Canonical Ensemble Application Problems	Dropbox	Due by the end of the module.	5 hours	70
3.5 Biological Applications of Thermodynamics: Experiment	Dropbox	Due by the end of the module.	3 hours	40
Totals			14 hours*	130

* These times are only estimates. Actual assignment completion times will vary.

Module Four Outline

Title	Type	Due Dates	Time	Points
4.1 Robert Boyle on Knowledge of God	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0

4.2 Reading	Reading	Complete prior to assignments.	1:30 hours	0
4.3 Ensembles in Everyday Life	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
4.4 Grand Canonical Application Problems	Dropbox	Due by the end of the module.	5 hours	70
4.5 Assessment of Ensembles	Dropbox	Due by the end of the module.	3 hours	40
Totals			12 hours*	130

* These times are only estimates. Actual assignment completion times will vary.

Module Five Outline

Title	Type	Due Dates	Time	Points
5.1 William Thompson (Lord Kelvin) on Affirming a Creative Power	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
5.2 Reading	Reading	Complete prior to assignments.	4 hours	0
5.3 Quantum Clarity	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
5.4 Quantum Statistics Application Problems	Dropbox	Due by the end of the module.	5 hours	70
Totals			11:30 hours*	90

* These times are only estimates. Actual assignment completion times will vary.

Module Six Outline

Title	Type	Due Dates	Time	Points
6.1 Science's Laws of Nature	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
6.2 Reading	Reading	Complete prior to assignments.	2 hours	0
6.3 Achieving the Ideal	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
6.4 Kinetic Theory and Transport Phenomena Application Problems	Dropbox	Due by the end of the module.	5 hours	70
6.5 Thermodynamics of Ideal Gases and Climate Change	Dropbox	Due by the end of the module.	3 hours	50
Totals			12:30 hours*	140

* These times are only estimates. Actual assignment completion times will vary.

Module Seven Outline

Title	Type	Due Dates	Time	Points
7.1 Reading	Reading	Complete prior to assignments.	2 hours	0

7.2 Science's Laws of Nature (Cont'd.)	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	30
7.3 Ideal Bose Systems Application Problems	Dropbox	Due by the end of the module.	5 hours	70
7.4 Challenges of BEC Theory	Dropbox	Due by the end of the module.	3 hours	40
Totals			12 hours*	140

* These times are only estimates. Actual assignment completion times will vary.

Module Eight Outline

Title	Type	Due Dates	Time	Points
8.1 TBD	Devotional	Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	30 minutes	0
8.2 Reading	Reading	Complete prior to assignments.	3 hours	0
8.3 Applying Statistical Mechanics	Discussion	Initial post due by the end of the fourth day of the module; two responses due by the end of the module.	2 hours	20
8.4 Ideal Fermi Systems Application Problems	Dropbox	Due by the end of the module.	5 hours	70
8.5 Bose versus Fermi	Dropbox	Due by the end of the module.	4 hours	50
8.6 End-of-Course Survey	Quiz	Due by the end of the module.	30 minutes	10 extra credit

Totals	14 hours*	140
---------------	----------------------	------------

* These times are only estimates. Actual assignment completion times will vary.

Course Assignments

COURSE TOTALS	96 hours*	1000
----------------------	------------------	------

* This time is only an estimate. Actual assignment completion times will vary.

Course Development Resources

Anderson, F. H. (1960). *Bacon, the new organon*. Upper Saddle River, NJ: Prentice Hall.

Einstein, A. (1991). *Out of my later years*. New York, NY: Citadel Press.

Gibbs, J. W. (1902). *Elementary principles in statistical mechanics developed with especial reference to the rational foundation of thermodynamics*. New York, NY: Scribner.

Lambert, F., Ph.D. (2005). *Shuffled cards, messy desks, and disorderly dorm rooms – examples of entropy increase? Nonsense!* [Originally published: *J. Chem. Educ.* 1999 76 1385.] Retrieved from http://entropysite.oxy.edu/shuffled_cards.html

MiT OpenCourseWare, Massachusetts Institute of Technology. (2013). *Statistical mechanics I: Problem set #1: Thermodynamics*. Retrieved from https://ocw.mit.edu/courses/physics/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/assignments/MIT8_333F13_pset1.pdf

MiT OpenCourseWare, Massachusetts Institute of Technology. (2013). *Statistical mechanics I: Problem set #4: Non-interacting particles*. Retrieved from https://ocw.mit.edu/courses/physics/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/assignments/MIT8_333F13_pset4.pdf

MiT OpenCourseWare, Massachusetts Institute of Technology. (2013). *Statistical mechanics I: Problem set #6: Ideal quantum gases*. Retrieved from https://ocw.mit.edu/courses/physics/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/assignments/MIT8_333F13_pset6.pdf

MiT OpenCourseWare, Massachusetts Institute of Technology. (2008).

Thermodynamics and kinetics lecture notes. Retrieved from
<https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/lecture-notes/>

Moritz, J. (2016). *Science and religion: Beyond warfare and toward understanding*.
Winona, MN: Anselm Academic.

Pearcy, N. R., Thaxton, C. B. (1994). *The soul of science: Christian faith and natural philosophy*. Wheaton, IL: Crossway Books.

PhET Interactive Simulations, University of Colorado Boulder. (2019). *Plinko probability*.
Retrieved from <https://phet.colorado.edu/en/simulation/plinko-probability>

Reynolds, O. (1892). *Memoirs of James Prescott Joule*. Manchester Literary and
Philosophical Society.

Thompson, S. P. (1910). *The life of William Thomson, baron Kelvin of Largs*. London:
Macmillan and Company. Retrieved from
<https://archive.org/details/lifeofwillthom02thomrich/page/n7>

All photos © AL unless otherwise noted.

Download and review the **PHYS-506 Credits Page.pdf**.

Expectations, Policies, and Important Student Information

School/Division	Link
DeVoe School of Business Division of Liberal Arts School of Services and Leadership	View School/Division Expectations, Policies, and Student Information
School of Educational Leadership	View School/Division Expectations, Policies, and Student Information
Wesley Seminary @ IWU	View School/Division Expectations, Policies, and Student Information
Nursing – Undergraduate	View School/Division Expectations, Policies, and Student Information
Nursing – Graduate	View School/Division Expectations, Policies, and Student Information