NS 542 Concepts in Physics III: Fluids and Thermodynamics
Course Schedule

N.B.: The schedule below has not yet been adapted to the blended schedule of online and in-class meetings. Course readings may vary between course offerings.

Session 1: Static Fluids

Sections from Cutnell & Johnson: 11.6, 11.1
Pretest on fluids, heat, and thermodynamics
Laboratory Activity: Fluids; atmospheric pressure.
Reading Assignment for online Discussion:

- Archimedes' On Floating Bodies from *Works of Archimedes.*
- Drake, Stillman. *Cause, Experiment & Science.* Selections. (p. 21 – 42)
- Recommended: Galileo, G. *Dialogues concerning two new sciences.* (pp. 64 – 86). Selections to be specified. Text available online at books.google.com.

ONLINE Session 2: Static Fluids and Pressure

Sections from Cutnell & Johnson: 11.2 – 11.5, 11.12
Web assignment 1

Fri. Jan. 11 Session 3: Fluid Demonstrations, and Fluid Dynamics I

Sections from Cutnell & Johnson: 11.7 – 11.10
Activity: Demonstrations related to atmospheric pressure and Bernoulli's equation
Activity: Applying Bernoulli's Equation
Reading Assignment for online Discussion:

- Loverude, M.E., Kautz, C.H., and Heron, P.R.L. (2003). Helping students develop an understanding of Archimedes' principle. I. Research on student understanding. *American Journal of Physics, 71*, 1178 – 1187.
- Heron, P.R.L., Loverude, M.E., Shaffer, P.S., and McDermott, L.C. (2003). Helping students develop an understanding of Archimedes' principle. II. Development of research-based instructional materials. *American Journal of Physics, 71*, 1188 – 1195.

ONLINE Session 4: Fluid Dynamics II

Sections from Cutnell & Johnson: 11.7 – 11.10
Activity: More applications of Bernoulli's Equation
Web assignment 2

Session 5: History/Philosophy/Education Research

Philosophy/History/Education Research: In class discussion of Archimedes and Galileo readings, and discussion of student misconceptions about buoyancy and Archimedes' principle.

ONLINE Session 6: Temperature and Thermal Expansion

Sections from Cutnell & Johnson: 12.1 – 12.8, 12.11

Activities: Temperature scales, Absolute Zero. Why are bridges and railroads built with gaps?
Web assignment 3
Reading Assignment for online Discussion:

- Toulmin, S. and Goodfield, J. (1962). Lavoisier's New System. In *The Architecture of Matter* (pp. 216-222). Chicago: Univ. Chicago Press.

Session 7: Heat and Heat transfer

Sections from Cutnell & Johnson: Chapter 13
Active Physics: Activity on conduction – "Home" Ch 1, Activity 5.
Laboratory Activity – Mechanical Equivalent of Heat (move to session 7)
Activity: Modes of heat transfer

ONLINE Session 8: Calorimetry

Equivalence of heat and energy—Joule's experiment; Specific heat; Latent Heat
Web assignment 4
Reading Assignment for online Discussion:

- Wiser, M. and Carey, S. (1983). When Heat and Temperature Were One. In Gentner, D. and Stevens, A.L. (Eds.) *Mental Models*. New York: Lawrence Erlbaum Associates, Publishers.

Session 9: Midterm exam

Laboratory Activity -- Specific heat

ONLINE Session 10: Kinetic theory

Sections from Cutnell & Johnson: Chapter 14
Activities: Temperature and kinetic energy; Ideal Gas Law; Maxwell distribution
Web assignment 5
Reading Assignment for online Discussion:

- Maxwell, J.C. (1996) Document 16: Molecules. In Garber, E., Brush, S.G. and Everitt, C.W.F. (Eds.) *Maxwell on Molecules.* Cambridge: MIT Press.

Session 11: The First Law of Thermodynamics

Sections from Cutnell & Johnson: Chapter 15.1 – 15.4
Activities: Thermodynamic processes, or How We Gain or Lose Weight
Philosophy/History/Education Research: In class discussion of readings on the historical theory of heat.
Reading Assignment for online Discussion:

- Kautz, C.H., Heron, P.R.L., Loverude, M.E., and McDermott, L.C. (2005). Student understanding of the ideal gas law, Part I: A macroscopic perspective. *American Journal of Physics*, 73 (11), 1055 – 1063.
- Kautz, C.H., Heron, P.R.L., Shaffer, P.S., and McDermott, L.C. (2005). Student understanding of the ideal gas law, Part II: A microscopic perspective. *American Journal of Physics*, 73 (11), 1064 – 1071.

ONLINE Session 12: The Second Law of Thermodynamics

Sections from Cutnell & Johnson: 15.5 – 15.7
Activities: More thermodynamic processes; Heat engines; Thermodynamic cycles
Web assignment 6
Reading Assignment for Session 12:

- Brush, S. (1983). VII. Statistical mechanics and the philosophy of science. In *Statistical physics and the atomic theory of matter.* Princeton: Princeton Univ. Press.

Session 13: The Ever-Increasing Entropy
Sections from Cutnell & Johnson: 15.8 – 15.10, 15.13
Activities: Statistical viewpoint of entropy—why does heat flow from hot to cold?
Philosophy/History/Education Research: Misconceptions in thermodynamics
Take home exam handed out

Session 14: Wrap-up
Take home exam due
Student's presentations.
Course evaluation.

Bibliography

Selections from primary sources

Drake, Stillman (1981). *Cause, Experiment and Science.* (Chicago). University of Chicago Press.
This is a recommended book. This book is available online for less than $1. Principal cost is shipping.

Einstein, A. (1915). Theoretical Atomism. In *The Collected Papers of Albert Einstein, Volume 4.* Princeton University Press.

Heath, T.L. (1953). *Works of Archimedes.* (New York). Dover.
This is a recommended book. Available online for about $17 plus shipping.

Maxwell, J.C. (1996) Document 16: Molecules. In Garber, E., Brush, S.G. and Everitt, C.W.F. (Eds.) *Maxwell on Molecules.* Cambridge: MIT Press.

Selections from secondary sources

Wiser, M. and Carey, S. (1983). When Heat and Temperature Were One. In Gentner, D. and Stevens, A.L. (Eds.) *Mental Models*. New York: Lawrence Erlbaum Associates, Publishers.

Toulmin, S. and Goodfield, J. (1962). Lavoisier's New System. In *The Architecture of Matter* (pp. 216-222). Chicago: Univ. Chicago Press.
This is a required book for the course.

Brush, S. (1983). VII. Statistical mechanics and the philosophy of science. In *Statistical physics and the atomic theory of matter.* Princeton: Princeton Univ. Press.

Selections from Physics Education Research Literature

Loverude, M.E., Kautz, C.H., and Heron, P.R.L. (2003). Helping students develop an understanding of Archimedes' principle. I. Research on student understanding. *American Journal of Physics*, 71 (11), 1178 – 1187.

Heron, P.R.L., Loverude, M.E., Shaffer, P.S., and McDermott, L.C. (2003). Helping students develop an understanding of Archimedes' principle. II. Development of research-based instructional materials. *American Journal of Physics*, 71, 1188 – 1195.

Kautz, C.H., Heron, P.R.L., Loverude, M.E., and McDermott, L.C. (2005). Student understanding of the ideal gas law, Part I: A macroscopic perspective. *American Journal of Physics*, 73 (11), 1055 – 1063.

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