

EK424 THERMODYNAMICS AND STATISTICAL MECHANICS (Spring 2009)

Thermodynamics is the study of processes (e.g., expansion of a gas, boiling of water, or diffusion of ions across a membrane). When is a process favorable? When is it unfavorable or impossible? How much energy does a process require in order to take place? We will study the thermodynamics of two types of processes: mechanical and chemical. Biological systems make wide use of both forms (e.g., in the mechanical beating of a heart, or the chemical conversion of glucose into useful work), and a good understanding of thermodynamics is essential for designing molecules that interact with living organisms.

Course information: We will examine all of the usual topics in chemical thermodynamics. This course will emphasize a statistical/molecular view.

The class meets from 10 am to 12 pm Mondays and Wednesdays in SCI 115. Prerequisites for this class include chemistry (CH102), calculus (MA226), and physics (PY212). EK424 itself is a prerequisite for molecular bioengineering (BE505/506) and biomolecular architecture (BE560).

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Textbooks: Dill and Bromberg, *Molecular Driving Forces* (required; used in 2005-2008)
Various documents will be provided on the EK424 Courseinfo website
(<http://courseinfo.bu.edu>)

For more information:

Connors, *Thermodynamics of Pharmaceutical Systems* (practical examples; used in 2004)
Denbigh, *Principles of Chemical Equilibrium* (used in 2003)

The OpenCourseWare webpage at MIT (<http://ocw.mit.edu>) has useful information, in particular Statistical Thermodynamics of Biomolecular Systems (BE.011J).

Grading:	Final exam	50%
	Midterm	25%
	Homework	25%

Weekly homework assignments are due at the end of Monday. Late homework will not be accepted. Working with others is acceptable.

TENTATIVE TIMELINE

Dates	Topics	Reading
Jan 14	Introduction	
19	No Class	Ch. 5 (p. 61-79) Ch. 1 (p. 1-23) Ch. 4 (p. 49-59)
21	1 st Law; kinetic theory	Ch. 3 (p. 37-43)
26	Cycles	Ch. 7 (p. 119-127) Ch. 8 (p. 147-150)
28	Entropy; 2 nd Law; equilibrium	Ch. 6 (p. 81-85)
Feb 2	Partition function; Boltzmann distribution	Ch. 10 (p. 171-189)
4	Expected values	
9	Partition function, part II	
11	Partition function, part III	
16	No Class	
17	Chemical equilibrium	Ch. 7 (p. 105-119)
18	Chemical potential	
23	Free energies; enthalpy	Ch. 8 (p. 131-146)
25	Maxwell's relations	Ch. 9 (p. 153-166)
Mar 2	Review	
4	Midterm	
9	No Class	
11	No Class	
16	Chemical reactions	Ch. 13 (p. 235-243)
18	Reactions in gases	Ch. 15 (p. 267-273)
23	Reactions in liquids	Ch. 16 (p. 282-285)
25	Acid-base equilibria	Ch. 13 (p. 243-248) Ch. 27 (p. 515-522)
30	Acid-base equilibria, part II	
Apr 1	Binding reactions	Ch. 28 (p. 533-546)
6	Cooperative binding	
8	Phase transitions	Ch. 14 (p. 251-261)
13	Colligative properties	Ch. 16 (p. 279-291)
15	Osmosis	
20	No Class	
22	Extractions	Ch. 16 (p. 291-297)
27	Electrochemical reactions	Ch. 22 (p. 409-417)
29	Review	

Final Exam: Thursday, May 7 (3pm until 5pm)