Material for Week 2

Physics 4488/6562: Statistical Mechanics

https://sethna.lassp.cornell.edu/Teaching/562/

Exercises due Mon. Feb 03

Last correction at January 16, 2025, 6:35 pm

The exercises with numbers N1.xxx are to be found in https://sethna.lassp.cornell.edu/StatMech/SethnaExercises.pdf

All exercises are from the second edition of the text: https://sethna.lassp.cornell.edu/StatMech/EntropyOrderParametersComplexity20.pdf

Monday

In-class question: 2.2 *Photon diffusion in the Sun*

In-class question: 2.15 *Diffusion of nonconserved particles*

In-class question: 2.16 *Density dependent diffusion*

Wednesday

Read: Chapter 2, Sec. 2.4 (Solving: Fourier & Green)

Pre-class question: 2.18 *Absorbing boundary conditions*

In-class question: 2.6 *Fourier and Green*

Friday

Read: Chapter 3, Sec. 3.1 (Microcanonical), 3.2 (Ideal Gas), 3.3 (Temperature) and pressure parts of 3.4 (Pressure & Chemical Potential)

Pre-class question: 3.13 *Weirdness in high dimensions*

In-class question: 3.5 *Hard sphere gas*

Monday

Read: Chapter 3, chemical potential parts of 3.4 (Pressure & Chemical Potential; 3.4.1 is optional) and Sec. 3.5 (Entropy & fussy stuff).

Pre-class question: 3.10 *Triple product relation*

Assigned exercise for everyone

2.5 *Generating random walks.* (Computation) Monte Carlo. Central limit theorem. Emergent symmetry! Hints at https://sethna.lassp.cornell.edu/StatMech/EOPCHintsAndMaterials.html

Special topic exercises (6562 do one; 4488 do 7 during 14 weeks)

N1.22 *Random walks on a lattice.* Vacancy diffusion in silicon.

8.4 *Red and green bacteria.* (Mathematics, Biology) Analyze the system as a random walk in the number of red bacteria. Applications to gene fixation, species extinction. Full credit for sensible arguments that get within a factor of two of the right answer. (Assigned to me for my qualifying exam at Princeton.)

2.11 *Stocks, volatility, and diversification.* (Finance, Computation) Stock prices are random walks, but with 'fat tails'. Hints at https://sethna.lassp.cornell.edu/StatMech/EOPCHintsAndMaterials.html

N1.9 *Chiral waves: Fourier and Green.* Studies weird wave equation that arises in chiral edge state dynamics of topological materials.

2.20 *Flocking.* (Active matter) Animal migration as a random walk in orientation space. Animals can choose a direction in 2D: why can't physicists?

2.19 *Run & tumble.* (Active matter, Biology) Here we study the eating strategies of bacteria. When to sit and wait for food to come by? When to swim, when to turn?

3.19 *Random energy model.* Advanced statistical mechanics. The simplest model exhibiting a glass transition.