Table of Contents

Preface
Contents
List of figures

What is statistical mechanics?
1.1:Quantum dice and coins
1.2:Probability distributions
1.3:Waiting time paradox
1.4:Stirling's formula
1.5:Stirling and asymptotic series
1.6:Random matrix theory
1.7:Six degrees of separation
1.8:Satisfactory map colorings
1.9:First to fail: Weibull
1.10:Emergence
1.11:Emergent vs. fundamental
1.12:Self-propelled particles
1.13:The birthday problem
1.14:Width of the height distribution
1.15:Fisher information and Cram´er–Rao
1.16:Distances in probability space

Random walks and emergent properties
2.1:Random walk examples: universality and scale invariance
2.2:The diffusion equation
2.3:Currents and external forces
2.4:Solving the diffusion equation

Temperature and equilibrium
3.1:The microcanonical ensemble
3.2:The microcanonical ideal gas
3.3:What is temperature?
3.4:Pressure and chemical potential
3.5:Entropy, the ideal gas, and phase-space refinements

Phase-space dynamics and ergodicity

4.1:Liouville’s theorem
4.2:Ergodicity

Entropy
5.1:Entropy as irreversibility: engines and the heat death of the Universe
5.2:Entropy as disorder
5.3:Entropy as ignorance: information and memory

Free energies
6.1:The canonical ensemble
6.2:Uncoupled systems and canonical ensembles
6.3:Grand canonical ensemble
6.4:What is thermodynamics?
6.5:Mechanics: friction and fluctuations
6.6:Chemical equilibrium and reaction rates
6.7:Free energy density for the ideal gas

Quantum statistical mechanics
7.1:Mixed states and density matrices
7.2:Quantum harmonic oscillator
7.3:Bose and Fermi statistics
7.4:Non-interacting bosons and fermions
7.5:Maxwell–Boltzmann ‘quantum’ statistics
7.6:Black-body radiation and Bose condensation
7.7:Metals and the Fermi gas

Calculation and computation
8.1:The Ising model
8.2:Markov chains
8.3:What is a phase? Perturbation theory

Order parameters, broken symmetry, and topology
9.1:Identify the broken symmetry
9.2:Define the order parameter
9.3:Examine the elementary excitations
9.4:Classify the topological defects

Correlations, response, and dissipation

10.1:Correlation functions: motivation
10.2:Experimental probes of correlations
10.3:Equal-time correlations in the ideal gas
10.4:Onsager's regression hypothesis and time correlations
10.5:Susceptibility and linear response
10.6:Dissipation and the imaginary part
10.7:Static susceptibility
10.8:The fluctuation-dissipation theorem
10.9:Causality and Kramers–Kr¨onig

Abrupt phase transitions
11.1:Stable and metastable phases
11.2:Maxwell construction
11.3:Nucleation: critical droplet theory
11.4:Morphology of abrupt transitions

Continuous phase transitions
12.1:Universality
12.2:Scale invariance
12.3:Examples of critical points

A Appendix: Fourier methods
A.1:Fourier conventions
A.2:Derivatives, convolutions, and correlations
A.3:Fourier methods and function space
A.4:Fourier and translational symmetry

References
Index