## **CONTENTS**

A	THERMODYNAMICS	AND	KINETIC	THEODY
А	INCRIMODINAMICS	AIND	NINE III	IMPURY

#### CHAPTER 1 THE LAWS OF THERMODYNAMICS, 3

- 1.1 Preliminaries, 3
- 1.2 The First Law of Thermodynamics, 7
- 1.3 The Second Law of Thermodynamics, 10
- 1.4 Entropy, 15
- 1.5 Some Immediate Consequences of the Second Law, 20
- 1.6 Thermodynamic Potentials, 23
- 1.7 The Third Law of Thermodynamics, 26

## CHAPTER 2 SOME APPLICATIONS OF THERMODYNAMICS, 33

- 2.1 Thermodynamic Description of Phase Transitions, 33
- 2.2 Surface Effects in Condensation, 38
- 2.3 Van der Waals Equation of State, 40
- 2.4 Osmotic Pressure, 46

#### CHAPTER 3 THE PROBLEM OF KINETIC THEORY, 55

- 3.1 Formulation of the Problem, 55
- 3.2 Binary Collisions, 59
- 3.3 Boltzmann Transport Equation, 65

x Content	'S	
CHAPTER	4	THE EQUILIBRIUM STATE OF A DILUTE GAS, 68
	4.1	Boltzmann's H Theorem, 68
	4.2	
	4.3	The Method of the Most Probable Distribution, 75
	4.4	Analysis of the H Theorem, 84
	4.5	Two "Paradoxes," 88
	4.6	Validity of the Boltzmann Transport Equation, 89
CHAPTER	5	TRANSPORT PHENOMENA, 93
	5.1	The Mean Free Path, 93
	5.2	The Conservation Laws, 95
	5.3	
	5.4	
	5.5	Viscosity, 107
	5.6	Viscous Hydrodynamics, 111
	5.7	The Navier-Stokes Equation, 112
	5.8	Examples in Hydrodynamics, 116
CHAPTER	6	THE CHAPMAN-ENSKOG METHOD, 124
	6.1	Purpose of the Method, 124
	6.2	The Chapman-Enskog Expansion, 125
	6.3	
	6.4	
	В	STATISTICAL MECHANICS
CHAPTER	7	CLASSICAL STATISTICAL MECHANICS, 139
	7.1	The Postulate of Classical Statistical Mechanics, 139
	7.2	
	7.3	Derivation of Thermodynamics, 147
	7.4	
		Classical Ideal Gas, 151
	7.6	Gibbs Paradox, 153
CHAPTER	8	CANONICAL ENSEMBLE AND GRAND CANONICAL ENSEMBLE, 156
	8.1	Canonical Ensemble, 156
	8.2	
	8.3	Grand Canonical Ensemble, 162
		7 T.T.

Density Fluctuations in the Grand Canonical Ensemble, 165

8.4

	Contents xi
8.5 8.6 8.7	Equivalence of the Canonical Ensemble and the Grand Canonical Ensemble, 168 Behavior of W(N), 172 The Meaning of the Maxwell Construction, 174
CHAPTER 9	QUANTUM STATISTICAL MECHANICS, 183
9.1 9.2 9.3 9.4 9.5 9.6 9.7	The Postulates of Quantum Statistical Mechanics, 183 Density Matrix, 186 Ensembles in Quantum Statistical Mechanics, 188 Third Law of Thermodynamics, 191 The Ideal Gases: Microcanonical Ensemble, 192 The Ideal Gases: Grand Canonical Ensemble, 197
CHAPTER 10	THE PARTITION FUNCTION, 206
10.1 10.2 10.3	Classical Limit of the Partition Function, 213
CHAPTER 11	IDEAL FERMI GAS, 224
11.1 11.2 11.3 11.4 11.5	Theory of White Dwarf Stars, 230 Landau Diamagnetism, 237 De Haas-Van Alphen Effect, 243
CHAPTER 12	IDEAL BOSE GAS, 253
12.1 12.2 12.3 12.4	Photons, 253 Phonons, 258 Bose-Einstein Condensation, 262
CHAPTER 13	IMPERFECT GASES AT LOW TEMPERA- TURES, 274
13.1 13.2	Definition of the Problem, 274 Method of Pseudopotentials in Two-Body Problems, 275

- 13.3 Method of Pseudopotentials in N-Body Problems, 280
- An Imperfect Fermi Gas, 282 13.4
- 13.5 An Imperfect Bose Gas, 289

### CHAPTER 14 CLUSTER EXPANSIONS, 297

14.1 Classical Cluster Expansion, 297

14.2 14.3	Quantum Cluster Expansion, 303 The Second Virial Coefficient, 307
CHAPTER 15	PHASE TRANSITIONS, 313
15.3	Formulation of the Problem, 313 The Theory of Yang and Lee, 316 The Gas Phase, 320 Van Hove's Theorem, 321
C	SPECIAL TOPICS IN STATISTICAL MECHANICS
CHAPTER 16	THE ISING MODEL, 329
16.1 16.2 16.3 16.4 16.5	Bragg-Williams Approximation, 336
CHAPTER 17	THE ONSAGER SOLUTION, 349
	Formulation of Two-Dimensional Ising Model, 349 Mathematical Digression, 355 The Solution, 359
CHAPTER 18	LIQUID HELIUM, 374
18.3 18.4 18.5	Tisza's Two-Fluid Model, 379 The Theories of Landau and Feynman, 381 Equilibrium Properties Near Absolute Zero, 392 Motion of the Superfluid, 393 Kinetic Theory Near Absolute Zero, 397
CHAPTER 19	HARD-SPHERE BOSE GAS, 409
19.1 19.2 19.3 19.4 19.5 19.6	Perturbation Theory, 410 A New Perturbation Method, 416 The Ground State and Low Excited States, 420

#### D APPENDICES

# APPENDIX A N-BODY SYSTEM OF IDENTICAL PARTICLES, 439

- A.1 The Two Kinds of Statistics, 439
- A.2 N-Body Wave Functions, 441
- A.3 Method of Quantized Fields, 448

#### APPENDIX B THE PSEUDOPOTENTIAL, 455

### APPENDIX C THE THEOREMS OF YANG AND LEE, 458

- C.1 Two Lemmas, 458
- C.2 Theorem 1 of Yang and Lee, 461
- C.3 Theorem 2 of Yang and Lee, 463

INDEX, 465