CONTENTS

Preface to the Russian edition	v
Translator's preface	ix
Biographical notes about the author	xi
Introduction	1
Chapter I. Survey of basic theoretical concepts	5
§1. Basic results of the thermodynamic method §2. Basic ideas, concepts, and theorems in the theory of prob-	5
ability §3. The Maxwell—Boltzmann distribution as an illustration of	14
the statistical method	24
Problems on Chapter I	29
Chapter II. Basic concepts of classical statistical mechanics	30
§4. General mechanical model. Phase space	30
§5. Statistical description of the mechanical system	32
§6. Liouville's theorem on the conservation of volume in	24
phase space	34 38
§7. The recurrence theorem of Poincaré and Zermelo §8. The law of motion for a statistical ensemble	30 39
Problems on Chapter II	42
Chapter III. Classical theory of equilibrium states	44
§9. Equilibrium statistical ensemble	44
§ 10. Microcanonical distribution	47
§11. Gibbs' canonical distribution	50
§12. Canonical distribution and thermodynamics	56
§13. Some general properties of the canonical distribution. Its	
connection to the microcanonical distribution	60

xiv	Contents

§14. Calculation of the free energy of an ideal gas. Gibbs'	
paradox	64
§15. Mean density of particles in μ -space and the occupation	(0
number for an ideal gas	68 74
§16. The law of equipartition of kinetic energy between the	74
§17. The law of equipartition of kinetic energy between the degrees of freedom. The virial theorem	79
§18. Application of the equipartition theorem and the virial	19
theorem to concrete systems	83
§19. The Gibbs distribution for systems with a variable num-	05
ber of particles	92
•	.8.4
Problems on Chapter III	96
Chapter IV. Theory of fluctuations	100
§20. Determination of the correlation moments as the funda-	
mental problem of the theory of fluctuations	100
§21. Calculation of quadratic correlations according to Gibbs'	
method	102
§22. Application of Gibbs' general method to concrete systems	104
§23. Calculation of the probability density for an arbitrary	
generalized coordinate	109
§24. The basic problem in the theory of Brownian motion	111
§25. General method for calculation of quadratic time correla-	112
tions	113 118
§26. The Einstein-Fokker-Planck equation	110
§27. Investigation of some solutions of the Einstein-Fokker-	125
Planck equation	123
§28. Nyquist's formula	
Problems on Chapter IV	131
Chapter V. Classical statistical theory of non-equilibrium processes	134
§29. Non-equilibrium distribution function	134
§30. Exact equations for the distribution function	135
§31. Kinetic equation in the presence of long-range forces	139
§32. The Boltzmann kinetic equation	140
§33. Stationary solution of the Boltzmann equation	145
§34. The Boltzmann H-theorem	147
§35. Relation between H-function and entropy	149
§36. Increase of the Gibbs entropy	151

Contents	xv

§37. Macroscopic irreversibility and microscopic reversibility	155
§38. Entropy and information	160
Problems on Chapter V	166
Chapter VI. Quantum statistics	168
§39. Quantal model of matter	168
§40. The canonical distribution in quantum statistics	170
§41. The quantum oscillator	173
§42. Planck's formula for the equilibrium radiation of a per-	
fectly black body	175
§43. Heat capacity of solids	179
§44. Heat capacity of a diatomic ideal gas	184
§45. Quantum statistics of a system of similar particles	187
§46. Bose-Einstein and Fermi-Dirac statistics	193
§47. Application of Bose-Einstein statistics to the photon gas	198
§48. Application of Fermi-Dirac statistics to the electron gas in a metal	200
§49. Condensation of an ideal Bose-Einstein gas	203
Problems on Chapter VI	207
Chapter VII. Some general problems of statistical physics	210
§50. The limits of application of classical thermodynamics	210
§51. Statistical meaning of negative temperatures	214
§52. The "arrow of time", the causality principle, and the	
second law of thermodynamics	218
Answers and solutions to the problems	226
Chapter I	226
Chapter II	227
Chapter III	229
Chapter IV	244
Chapter V	251
Chapter VI	257
List of symbols	266
Index	272