

Contents

Preface to the Berkeley Physics Course v Preface to Volume V vii Acknowledgments ix Teaching and Study Notes xi

Chapter 1 Characteristic Features of Macroscopic Systems 1

- 1.1 Fluctuations in Equilibrium 4
- 1.2 Irreversibility and the Approach to Equilibrium 15
- 1.3 Further Illustrations 29
- 1.4 Properties of the Equilibrium Situation 31
- 1.5 Heat and Temperature 35
- 1.6 Typical Magnitudes 39
- Important Problems of Macroscopic Physics 45
 Summary of Definitions 50
 Suggestions for Supplementary Reading 51
 Problems 51

Chapter 2 Basic Probability Concepts 55

- 2.1 Statistical Ensembles 56
- 2.2 Elementary Relations among Probabilities 64
- 2.3 The Binomial Distribution 67
- 2.4 Mean Values 75
- 2.5 Calculation of Mean Values for a Spin System 80
- 2.6 Continuous Probability Distributions 86
 Summary of Definitions 90
 Important Relations 90
 Suggestions for Supplementary Reading 91
 Problems 91

xviii Contents

3.1 3.2 3.3 3.4 3.5 3.6 3.7	Statistical Postulates 111 Probability Calculations 116 Number of States Accessible to a Macroscopic System	118
	Chapter 4 Thermal Interaction 141	
4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8	The Approach to Thermal Equilibrium 147 Temperature 149 Small Heat Transfer 155 System in Contact with a Heat Reservoir 157	142

Chapter 3 Statistical Description of Systems of Particles 99

Contents xix

5.1	Determination of the Absolute Temperature 192	
5.2	High and Low Absolute Temperatures 196	
5.3		
5.4	Heat Capacity 206	
5.5	Entropy 209	
5.6	Intensive and Extensive Parameters 211	
	Summary of Definitions 213	
	Important Relations 213	
	Suggestions for Supplementary Reading 213	
	Problems 214	
	Chapter 6 Canonical Distribution in the Classical Approximation 9	223
	Chapter 6 Canonical Distribution in the Classical Approximation 2	23
6.1	The Classical Approximation 224	
6.2	Maxwell Velocity Distribution 231	
6.3	TOTAL TO THE PART OF THE PART	
6.4	Effusion and Molecular Beams 240	
6.5	The Equipartition Theorem 246	
6.6	Applications of the Equipartition Theorem 248	
6.7	The Specific Heat of Solids 250	
•••	Summary of Definitions 256	
	Important Relations 256	
	Suggestions for Supplementary Reading 256	
	Problems 257	

Chapter 5 Microscopic Theory and Macroscopic Measurements 191

Chapter 7 General Thermodynamic Interaction 265

- 7.1 Dependence of the Number of States on the External Parameters 266
- 7.2 General Relations Valid in Equilibrium 271
- 7.3 Applications to an Ideal Gas 276
- 7.4 Basic Statements of Statistical Thermodynamics 281
- 7.5 Equilibrium Conditions 286
- 7.6 Equilibrium between Phases 292
- 7.7 The Transformation of Randomness into Order 299
 Summary of Definitions 307
 Important Relations 307
 Suggestions for Supplementary Reading 308
 Problems 308

Chapter 8 Elementary Kinetic Theory of Transport Processes 317

- 8.1 Mean Free Path 319
- 8.2 Viscosity and Transport of Momentum 323
- 8.4 Self-diffusion and Transport of Molecules 335
- 8.5 Electrical Conductivity and Transport of Charge 339
 Summary of Definitions 342
 Important Relations 342
 Suggestions for Supplementary Reading 343
 Problems 343

Contents xxi

Appendix 349

- A.1 Gaussian Distribution 350
- A.2 Poisson Distribution 355
- A.3 Magnitude of Energy Fluctuations 357
- A.4 Molecular Impacts and Pressure in a Gas 360

Mathematical Notes 363

- M.1 The Summation Notation 364
- M.2 Sum of a Geometric Series 364
- M.3 Derivative of $\ln n!$ for large n = 365
- M.4 Value of $\ln n!$ for large n=366
- **M.5** The Inequality $\ln x \le x 1$ 367
- **M.6** Evaluation of the Integral $\int_{-\infty}^{\infty} e^{-x^2} dx$ 367
- **M.7** Evaluation of Integrals of the Form $\int_{-\infty}^{\infty} e^{-\alpha x^2} x^n dx$ 369

Supplementary Problems 371 Mathematical Symbols 377 Greek Alphabet 379 Numerical Constants 381 Answers to Problems 383 Index 393