CONTENTS

PREFACE *page* vii

1. INTRODUCTION 1

2. THE ZEROTH AND FIRST LAWS OF THERMODYNAMICS 5

   Fundamental definitions 5
   Temperature 7
   Internal energy and heat 13

3. REVERSIBLE CHANGES 19

   Reversibility and irreversibility 19
   Different types of work 23

4. THE SECOND LAW OF THERMODYNAMICS 29

5. A MISCELLANY OF USEFUL IDEAS 43

   Dimensions and related topics 43
   Maxwell's thermodynamic relations 45
   Identity of the absolute and perfect gas scales of temperature 46
   Absolute zero, negative temperatures and the third law of thermodynamics 48
   An elementary graphical method for solving thermodynamic problems 53
   The functions U, H, F and G 55

6. APPLICATIONS OF THERMODYNAMICS TO SIMPLE SYSTEMS 57

   Introduction 57
   Relations between the specific heats 60
   The adiabatic equation 61
   Magnetic analogues of the foregoing results 63
   The Joule and Joule-Kelvin effects 68
   Radiation 77
   Surface tension and surface energy 84
   Establishment of the absolute scale of temperature 87

7. The Thermodynamic Inequalities page 94
The increase of entropy 94
The decrease of availability 100
The conditions for equilibrium 104

8. Phase Equilibrium 112
The phase diagram of a simple substance 112
Clapeyron's equation 115
Liquid-vapour equilibrium and the critical point 116
Solid-liquid equilibrium 122
The phase diagram of helium 124
The superconducting phase transition 129

9. Higher-Order Transitions 136
Classification of transitions 136
Analogues of Clapeyron's equation 140
Critique of the theory of higher-order transitions 146

Exercises 160

Index 163