## Table of Contents

- Preface
- 1 Introduction
- 1.1 Origins of Chemical Thermodynamics
- 1.2 Objectives of Chemical Thermodynamics
- 1.3 Limitations of Classic Thermodynamics
- References
- 2 Mathematical Preparation For Thermodynamics
- 2.1 Variables of Thermodynamics
- Extensive and Intensive Quantities
- Units and Conversion Factors
- 2.2 Analytic Methods
- Partial Differentiation
- Exact Differentials
- Homogeneous Functions
- Exercises
- References
- 3 The First Law of Thermodynamics
- 3.1 Definitions
- Temperature
- Work
- 3.2 The First Law of Thermodynamics
- Energy
- Heat
- General Form of the First Law
- Exercises
- References
- 4 Enthalpy, Enthalpy of Reaction, and Heat Capacity
- 4.1 Enthalpy
- Definition
- Relationship between Q v and Q p
- 4.2 Enthalpy of Reactions
- Definitions and Conventions
- 4.3 Enthalpy as a State Function
- Enthalpy of Formation from Enthalpy of Reaction
- Enthalpy of Solid-State Reaction from Measurements of Enthalpy of Solution
- Enthalpy of Formation from Enthalpy of Combustion
- Enthalpy of Transition from Enthalpy of Combustion
- Enthalpy of Conformational Transition of a Protein from Indirect Calorimetric Measurements
- 4.4 Bond Enthalpies
- Definition of Bond Enthalpies
- Calculation of Bond Enthalpies
- Enthalpy of Reaction from Bond Enthalpies
- 4.5 Heat Capacity

- Definition
- Some Relationships between C p and C v
- Other Sources of Heat Capacity Data
- Heat Capacities of Gases
- Heat Capacities of Solids
- Heat Capacities of Liquids
- 4.6 Enthalpy of Reaction as a Function of Temperature
- Analytic Method
- Arithmetic Method
- Graphical or Numerical Methods
- Exercises
- References
- 5 Applications of the First Law to Gases
- 5.1 Ideal Gases
- Definition
- Enthalpy as a Function of Temperature Only
- Relationship Between C p and C v
- Calculation of the Thermodynamic Changes in Expansion Processes
- 5.2 Real Gases
- Equations of State
- Joule-Thomson Effect
- Calculations of Thermodynamic Quantities in Reversible Expansions
- Exercises
- References
- 6 The Second Law of Thermodynamics
- 6.1 The Need for a Second Law
- 6.2 The Nature of the Second Law
- Natural Tendencies Toward Equilibrium
- Statement of the Second Law
- Mathematical Counterpart of the Verbal Statement
- 6.3 The Carnot Cycle
- The Forward Cycle
- The Reverse Cycle
- Alternative Statement of the Second Law
- Carnot's Theorem
- 6.4 The Thermodynamic Temperature Scale
- 6.5 The Definition of S, the Entropy of a System
- 6.6 The Proof that S is a Thermodynamic Property
- Any Substance in a Carnot Cycle
- Any Substance in Any Reversible Cycle
- Entropy S Depends Only on the State of the System
- 6.7 Entropy Changes in Reversible Processes
- General Statement
- Isothermal Reversible Changes
- Adiabatic Reversible Changes
- Reversible Phase Transitions

- Isobaric Reversible Temperature Changes
- Isochoric Reversible Temperature Changes
- 6.8 Entropy Changes in Irreversible Processes
- Irreversible Isothermal Expansion of an Ideal Gas
- Irreversible Adiabatic Expansion of an Ideal Gas
- Irreversible Flow of Heat from a Higher Temperature to a Lower Temperature
- Irreversible Phase Transitions
- Irreversible Chemical Reactions
- General Statement
- 6.9 General Equations for the Entropy of Gases
- Entropy of the Ideal Gas
- Entropy of a Real Gas
- 6.10 Temperature-Entropy Diagram
- 6.11 Entropy as an Index of Exh