

# TABLE OF CONTENTS

## Licensing

### 1: Introduction

- 1.1: Units
- 1.2: Quantity Calculus
- 1.3: Dimensional Analysis
- 1.4: Chapter 1 Problem

### 2: Systems and Their Properties

- 2.1: The System, Surroundings, and Boundary
- 2.2: Phases and Physical States of Matter
- 2.3: Some Basic Properties and Their Measurement
- 2.4: The State of the System
- 2.5: Processes and Paths
- 2.6: The Energy of the System
- 2.7: Chapter 2 Problems

### 3: The First Law

- 3.1: Heat, Work, and the First Law
- 3.2: Spontaneous, Reversible, and Irreversible Processes
- 3.3: Heat Transfer
- 3.4: Deformation Work
- 3.5: Applications of Expansion Work
- 3.6: Work in a Gravitational Field
- 3.7: Shaft Work
- 3.8: Electrical Work
- 3.9: Irreversible Work and Internal Friction
- 3.10: Reversible and Irreversible Processes- Generalities
- 3.11: Chapter 3 Problems

### 4: The Second Law

- 4.1: Types of Processes
- 4.2: Statements of the Second Law
- 4.3: Concepts Developed with Carnot Engines
- 4.4: Derivation of the Mathematical Statement of the Second Law
- 4.5: Irreversible Processes
- 4.6: Applications
- 4.7: Summary
- 4.8: The Statistical Interpretation of Entropy
- 4.9: Chapter 4 Problems

### 5: Thermodynamic Potentials

- 5.1: Total Differential of a Dependent Variable
- 5.2: Total Differential of the Internal Energy
- 5.3: Enthalpy, Helmholtz Energy, and Gibbs Energy
- 5.4: Closed Systems

- 5.5: Open Systems
- 5.6: Expressions for Heat Capacity
- 5.7: Surface Work
- 5.8: Criteria for Spontaneity
- 5.9: Chapter 5 Problems

## 6: The Third Law and Cryogenics

- 6.1: The Zero of Entropy
- 6.2: Molar Entropies
- 6.3: Cryogenics
- 6.4: Chapter 6 Problem

## 7: Pure Substances in Single Phases

- 7.1: Volume Properties
- 7.2: Internal Pressure
- 7.3: Thermal Properties
- 7.4: Heating at Constant Volume or Pressure
- 7.5: Partial Derivatives with Respect to  $\ln(T)$ ,  $\ln(p)$ , and  $\ln(V)$
- 7.6: Isothermal Pressure Changes
- 7.7: Standard States of Pure Substances
- 7.8: Chemical Potential and Fugacity
- 7.9: Standard Molar Quantities of a Gas
- 7.10: Chapter 7 Problems

## 8: Phase Transitions and Equilibria of Pure Substances

- 8.1: Phase Equilibria
- 8.2: Phase Diagrams of Pure Substances
- 8.3: Phase Transitions
- 8.4: Coexistence Curves
- 8.5: Chapter 8 Problems

## 9: Mixtures

- 9.1: Composition Variables
- 9.2: Partial Molar Quantities
- 9.3: Gas Mixtures
- 9.4: Liquid and Solid Mixtures of Nonelectrolytes
- 9.5: Activity Coefficients in Mixtures of Nonelectrolytes
- 9.6: Evaluation of Activity Coefficients
- 9.7: Activity of an Uncharged Species
- 9.8: Mixtures in Gravitational and Centrifugal Fields
- 9.9: Chapter 9 Problems

## 10: Electrolyte Solutions

- 10.1: Single-ion Quantities
- 10.2: Solution of a Symmetrical Electrolyte
- 10.3: Electrolytes in General
- 10.4: The Debye-Hückel Theory
- 10.5: Derivation of the Debye-Hückel Theory
- 10.6: Mean Ionic Activity Coefficients from Osmotic Coefficients
- 10.7: Chapter 10 Problems

## 11: Reactions and Other Chemical Processes

- 11.1: Mixing Processes
- 11.2: The Advancement and Molar Reaction Quantities
- 11.3: Molar Reaction Enthalpy
- 11.4: Enthalpies of Solution and Dilution
- 11.5: Reaction Calorimetry
- 11.6: Adiabatic Flame Temperature
- 11.7: Gibbs Energy and Reaction Equilibrium
- 11.8: The Thermodynamic Equilibrium Constant
- 11.9: Effects of Temperature and Pressure on Equilibrium Position
- 11.10: Chapter 11 Problems

## 12: Equilibrium Conditions in Multicomponent Systems

- 12.1: Effects of Temperature
- 12.2: Solvent Chemical Potentials from Phase Equilibria
- 12.3: Binary Mixture in Equilibrium with a Pure Phase
- 12.4: Colligative Properties of a Dilute Solution
- 12.5: Solid-Liquid Equilibria
- 12.6: Liquid-Liquid Equilibria
- 12.7: Membrane Equilibria
- 12.8: Liquid-Gas Equilibria
- 12.9: Reaction Equilibria
- 12.10: Evaluation of Standard Molar Quantities
- 12.11: Chapter 12 Problems

## 13: The Phase Rule and Phase Diagrams

- 13.1: The Gibbs Phase Rule for Multicomponent Systems
- 13.2: Phase Diagrams- Binary Systems
- 13.3: Phase Diagrams- Ternary Systems
- 13.4: Chapter 13 Problems

## 14: Galvanic Cells

- 14.1: Cell Diagrams and Cell Reactions
- 14.2: Electric Potentials in the Cell
- 14.3: Molar Reaction Quantities of the Cell Reaction
- 14.4: The Nernst Equation
- 14.5: Evaluation of the Standard Cell Potential
- 14.6: Standard Electrode Potentials
- 14.7: Chapter 14 Problems

## 15: Appendices

- 15.1: Appendix A- Definitions of the SI Base Units
- 15.2: Appendix B- Physical Constants
- 15.3: Appendix C- Symbols for Physical Quantities
- 15.4: Appendix D- Miscellaneous Abbreviations and Symbols
- 15.5: Appendix E- Calculus Review
- 15.6: Appendix F- Mathematical Properties of State Functions
- 15.7: Appendix G- Forces, Energy, and Work
- 15.8: Appendix H- Standard Molar Thermodynamic Properties
- 15.9: Appendix I- Answers to Selected Problems

[Index](#)

[Glossary](#)

[Detailed Licensing](#)