

Contents

<i>Preface</i>	xi
1 Introduction	1
1.1 Origins of thermodynamics	1
1.2 The macroscopic approach	2
1.3 The role of the laws	2
1.4 Systems, surroundings, and boundaries	3
1.5 Thermodynamic variables	5
1.6 Thermodynamic equilibrium	6
1.7 Thermodynamic reversibility	8
1.8 Degrees of freedom	10
1.9 Some useful mathematical results	12
2 The zeroth law	17
2.1 The zeroth law	17
2.2 Temperature	18
2.3 Scales of temperature	20
2.4 The perfect gas scale	20
2.5 Thermodynamic temperature	21
2.6 The Celsius scale	23
2.7 Some common thermometers	23
2.8 The International Practical Temperature Scale	28
3 The first law	30
3.1 Background to the first law	30
3.2 The first law	31
3.3 Internal energy	32
3.4 Heat	32
3.5 Work in various systems	35

viii	<i>Contents</i>	
3.6	Heat capacities	42
3.7	Enthalpy	45
3.8	Flow processes	46
4	The second law	50
4.1	The function of the second law	50
4.2	Cyclic processes and heat engines	50
4.3	Statements of the second law	53
4.4	Hotness and temperature	55
4.5	Carnot's theorem	56
4.6	Thermodynamic temperature	58
4.7	Uniqueness of reversible adiabatics	60
4.8	Refrigerators and heat pumps	62
4.9	Real heat engines	64
5	Entropy	68
5.1	Clausius' theorem	68
5.2	Entropy	71
5.3	Entropy in irreversible changes	72
5.4	The entropy form of the first law	74
5.5	Entropy and the degradation of energy	76
5.6	Entropy and order	77
6	The Carathéodory formulation of the second law	87
6.1	Introductory remarks	87
6.2	Empirical entropy	88
6.3	Empirical entropy and heat	93
6.4	Thermodynamic temperature and entropy	93
6.5	Irreversible changes	95
6.6	Subsequent development	97
7	Thermodynamic potentials	100
7.1	The potential functions	100
7.2	The Legendre differential transformation	103
7.3	Maxwell relations	104
7.4	General conditions for thermodynamic equilibrium	106
8	Applications to simple systems	112
8.1	Some properties of specific heat capacities	112
8.2	The perfect gas	116
8.3	Behaviour of real pure substances	120
8.4	The elastic rod or filament	124
8.5	The reversible electric cell	125
8.6	Surface tension	128

<i>Contents</i>	ix
8.7 Piezoelectricity	132
8.8 The magnetocaloric effect	134
8.9 Thermal radiation	144
8.10 Fluctuations	157
9 Applications to some irreversible changes	162
9.1 The Joule expansion	162
9.2 The Joule–Kelvin expansion	165
9.3 Liquefaction of gases	168
9.4 Thermoelectricity	172
10 Change of phase	180
10.1 Systems of more than one phase	180
10.2 The condition for equilibrium between phases	180
10.3 The Clausius–Clapeyron equation	182
10.4 Integration of the Clausius–Clapeyron equation	184
10.5 Gibbs functions in first order transitions	186
10.6 Critical points	188
10.7 Higher order change of phase	193
10.8 Some examples of higher order phase changes	194
10.9 Interpretation of second order transitions	203
10.10 The fountain effect with liquid helium	205
10.11 Surface effects	208
11 Systems of several components	213
11.1 Mixtures of ideal gases	213
11.2 Increase of entropy in diffusion	216
11.3 Chemical potential	218
11.4 Conditions for equilibrium	221
11.5 Ideal solutions	224
11.6 Ideal gas reactions	228
11.7 Solubility gaps in binary mixtures	231
11.8 Equilibrium between liquid and solid mixtures	236
12 The third law	241
12.1 The third law	241
12.2 Elementary physical consequences of the third law	242
12.3 Unattainability of absolute zero	245
12.4 Allotropic transformations	247
12.5 Glasses	249
12.6 The equilibrium constant	251

Cambridge University Press

978-0-521-27456-2 - Equilibrium Thermodynamics, Third Edition

C. J. Adkins

Table of Contents

[More information](#)

x	<i>Contents</i>	
	Appendix. Magnetic energy	253
	Useful data	256
	Problems	257
	References	278
	Index	281