

CONTENTS

PART I

PHASE EQUILIBRIUM

	<i>page</i>
<i>Chapter I Early Methods of Gas Liquefaction</i>	1
§1 December 1877	1
§2 The Cracow School	6
§3 Van der Waals' Equation and the Law of Corresponding States	9
<i>Chapter II Industrial Air Liquefaction</i>	13
§1 General Principles	13
§2 The Joule-Thomson Effect	18
§3 The Efficiency of Liquefiers	22
<i>Chapter III The Production of Low Temperatures</i>	35
§1 Leiden and Large-Scale Cryogenic Technique	35
§2 Cryostats	42
§3 Small-Scale Cryogenic Technique	47
<i>Chapter IV The Measurement of Low Temperatures</i>	52
§1 Gas Thermometry and the Kelvin Scale	52
§2 The Vapour Pressure as a Measure of Temperature	58
§3 Electrical Thermometry	62
<i>Chapter V Rectification in Theory and Practice</i>	65
§1 Binary Gases and their Equilibrium with Liquids	65
§2 The Rectification Column	69
§3 "Rectification Calculus"	72
§4 The Production of Pure Gases	81
<i>Chapter VI Solid Liquid Equilibrium</i>	88
§1 The Equilibrium Curve	88
§2 The Melting Curves of Condensed Gases	92
§3 Melting Diagrams of Binary Solids	98

< vii >

CONTENTS

PART II

THE SOLID STATE

<i>Chapter I</i>	The Crystal Lattice	<i>page</i> 103
§1	X-ray Methods at Low Temperatures	103
§2	Crystal Structures Stable at Low Temperatures	114
§3	Molecular Rotation in Crystals	130
<i>Chapter II</i>	The Thermal Energy of Crystals	136
§1	Low Temperature Calorimetry	136
§2	The Specific Heats of Crystals	141
<i>Chapter III</i>	Nernst's Third Law	179
§1	The Inaccessibility of Absolute Zero	179
§2	The Principal Significance of Nernst's Theorem	186

PART III

ORBIT AND SPIN

<i>Chapter I</i>	Internal Degrees of Freedom	191
§1	Degenerate States	191
§2	Ortho and Para Hydrogen	194
<i>Chapter II</i>	Paramagnetism	201
§1	Degeneracy, Magnetic Moment and Zeeman Effect	201
§2	Magnetic Measurements at Low Temperatures	205
§3	The Laws of Curie and Weiss	212
§4	Oxygen and Nitric Oxide	223
§5	Saturation, Langevin's Formula and the Faraday Effect	230
<i>Chapter III</i>	Magnetic Cooling	237
§1	The Magneto-Caloric Effect	237
§2	Problems connected with Magnetic Cooling	239
§3	Experimental Procedure and Results	248

< viii >

CONTENTS

PART IV

THE “FREE” ELECTRON

<i>Chapter I</i>	Conductivity at Low Temperatures	<i>page</i> 253
§1	Introductory	253
§2	Thermal Conductivity	254
§3	Electrical Conductivity	258
<i>Chapter II</i>	Supra-conductivity	269
§1	Introductory	269
§2	Permanent Currents	270
§3	The Transition Curve	272
§4	The Supra-conducting State	275
§5	Subpermeability	279
<i>Note added in Proof</i>		289
<i>Bibliography</i>		291
<i>Addenda</i>		309