

# CONTENTS

<b>PREFACE</b>		ix
<b>1. INTRODUCTION</b>		
1.1 Historical		1
1.2 Types of Discharge		2
<b>2. FUNDAMENTAL PROCESSES</b>		
2.1 The Kinetic Theory of a Simple Gas		6
2.2 Atomic and Molecular Structure		9
2.2.1 The Bohr-Rutherford Atom		9
2.2.2 Molecular Structure		13
2.3 Collisions		16
2.3.1 Cross-section		17
2.3.2 Elastic Collisions		20
2.3.3 Inelastic Collisions		25
2.3.4 Charge Transfer; the Penning Effect		27
2.3.5 Attachment and Recombination		28
2.4 Absorption and Emission of Radiation		31
2.5 Mobility		33
2.6 Diffusion		36
2.7 Electrode Effects		42
2.7.1 Thermionic Emission		42
2.7.2 Photoelectric Emission		43
2.7.3 Emission by Electron Impact		44
2.7.4 Emission by Positive-ion Impact		44
2.7.5 Emission by Neutral Atom Impact		45
2.7.6 Field Emission		45
<b>3. BREAKDOWN</b>		
3.1 The Townsend Discharge		47

3.2	Effect of Space Charge	55
3.3	Effect of Secondary Emission	57
3.4	Effect of Attachment	59
3.5	Similarity	61
3.6	The Townsend Criterion	61
3.7	Paschen's Law	63
3.8	Low-pressure Breakdown in Non-uniform Fields	65
3.9	Time of Breakdown	65
3.10	Breakdown at High Pressures	67
3.11	Non-uniform Field, High Pressure: Corona	70
3.12	High-frequency Breakdown	71
3.13	Effect of a Magnetic Field	77
4.	THE SELF-SUSTAINING DISCHARGE	
4.1	The D.C. Low-pressure Glow Discharge	80
4.1.1	The Cathode Region	83
4.1.2	The Negative Glow and Faraday Dark Space	85
4.1.3	The Positive Column	86
4.1.4	The Anode Fall	87
4.2	The High-pressure Glow Discharge	87
4.3	The D.C. Arc Discharge	88
4.3.1	Theories of Cathode Emission	90
4.3.2	Arc with Externally-heated Cathode	93
4.3.3	The Positive Column	93
4.3.4	The Anode Fall	94
4.3.5	Special Forms of Arc	94
4.3.6	The Drawn Arc	95
4.3.7	Electrode Evaporation	95
4.4	A.C. Discharges	96
4.4.1	Low and Intermediate Frequencies	96
4.4.2	High Frequencies	98
4.4.3	Superimposed A.C.	100
5.	EQUILIBRIUM	
5.1	General	102
5.2	Distribution Laws	104

5.3	Maxwell-Boltzmann Statistics	107
5.4	Einstein-Bose and Fermi-Dirac Statistics	112
5.5	Ionization—the Saha Equation	114
5.6	Detailed Balancing	118
5.7	Collision Rates	120
5.8	Radiation	123
5.9	Equilibrium in a Gas Discharge	127
5.9.1	The Approximation to Equilibrium	127
5.9.2	Co-existing Temperatures	128
5.10	The Druyvesteyn Distribution	129
5.11	The Boltzmann Equation	130
6.	PLASMA PROPERTIES	
6.1	The Positive Column	133
6.1.1	Low-pressure Column	133
6.1.2	High-pressure Column	135
6.2	The Ionosphere	137
6.3	Electromagnetic Waves in a Plasma	139
6.3.1	Low Pressure, High Frequency	139
6.3.2	Conditions for Absorption	142
6.4	High-current Discharges	146
6.4.1	General	146
6.4.2	The Bennett Equation	147
6.4.3	Transient Discharges	149
6.5	Debye Screening	152
6.6	Characteristic and Relaxation Times	154
6.7	Plasma Oscillations	156
7.	PLASMA MEASUREMENTS	
7.1	Probe Measurements	160
7.1.1	The Langmuir Probe Characteristic	160
7.1.2	Analysis of the Langmuir Characteristic	164
7.1.3	The Double Probe	169
7.2	Measurements from Emission Spectra	172
7.3	Microwave Measurements	177
7.4	Other Measurements	179

8.	APPLICATIONS	
8.1	Lighting	183
8.1.1	General	183
8.1.2	The Sodium Lamp	184
8.1.3	The High-pressure Mercury-vapour Lamp	187
8.1.4	The Low-pressure Mercury-vapour (Fluorescent) Lamp	190
8.1.5	Other Lamps	193
8.2	Electron Tubes	194
8.2.1	Gas Diodes	194
8.2.2	The Mercury-arc Rectifier	196
8.2.3	The Ignitron	198
8.2.4	Glow Discharge Tubes	199
8.2.5	Grid-controlled Tubes	202
8.2.6	Gas-filled Photocells	206
8.2.7	The Geiger Counter	207
8.2.8	Duplexers	209
8.3	Arc Welding	210
8.4	Arc Furnaces	213
8.5	Direct Power Generation	214
	Problems	217
	Index	227