CONTENTS

LIST	OF SYMBOLS.	•	•	•	•	•	•	xii
Снар	rer I. INTRODUCTIO	N						1
	A gas and a surface		_		-			1
	The fundamental cause	of adsor	ntion					1
	Technical applications							2
	The fundamental equati	010						3
	The full and the offere		•	•	•	•	•	Ũ
Снар	TER II. THE NUMBE	R n	•					4
5.	The kinetic theory of ga	ses	•	•	•	•		4
	The velocities of the mo			•	•			5
7.	The magnitude of n	•	•	•	•	•		6
	The number n for water	molecul	les in 'd	ry' atm	osphere	3		7
	The number n in high v					•		9
	A comparison with a 'ga		tronomy	7	•	•		10
	The rate of adsorption			•	•	•		11
	A magnified picture	•						12
	A comparison of gases o	f various	s pressu	res	•	•		13
	The dynamic equilibriur				its vapo	ur		14
	The maximum rate of e		-	•	. 1	•	•	15
	The rate of evaporation	- 			-			16
	Rate of evaporation in s			erations	3			17
	The dependence of n on							18
10.		·····						
Снарт	THE TIME $ au$			•	•	•		20
19.	Reflection of molecular	rays .	•		•	•	•	20
20.	Diffraction of molecular	waves .	•		•		•	23
21.	Exchange of heat: coeffi	cient of	accomm	nodation	i.			24
	Exchange of heat and it				•	•	•	26
	An attempt to measure			ŝ		•		29
	A stream of molecules th			ry			•	29
	The dependence of τ on							30
	τ , the time of adsorption					•	•	31
	Adsorption forces, physi		nemical	adsorpti	ion			31
	The magnitude of the					lium aı	nd	
	hydrogen .	• •	. 1		•	•		32
29.	Magnitude of τ and Q		•	•		•	•	34
	The resistance of capilla	ries in a	dsorptio	n				36
31.	Visualizing the passage	of a mole	ecule th	rough a	capillar	У		38

CONTENTS

Chapter IV. THE QUANTITY σ : THE DYNAMI	CEQUI	LIBRIU	JM	
IN ADSORPTION AND CONDENSATION PH	ENOME	NA		40
32. The magnitude of adsorption for helium and h	ydrogen			40
33. The magnitude of adsorption for other gases	•	•		42
34. The dynamic equilibrium at the surface.		•	•	44
35. The simplest form of the adsorption isotherm		•		45
36. Adsorption from solutions	•	•	•	46
37. The adsorption isobar	•	•		47
38. The adsorption isostere	•	•		48
39. The various heats of adsorption.	•	•	•	48
40. Vapour pressure and latent heat of evaporatio	n.	•	•	50
41. Rate of evaporation of a liquid in case of refle	ction of r	nolecule	es.	51
42. Heat of adsorption and entropy of adsorption	•	•		52
Chapter V. THE QUANTITY σ : UNIMOLECUL	AR ANI	O MULI	'I -	
MOLECULAR ADSORPTION	•		•	54
43. The Langmuir adsorption isotherm .	•	•	•	54
44. The form of the Langmuir adsorption isothern		•	•	56
45. The assumption of a constant heat of adsorption	on	•	•	58
46. The assumption of unimolecular adsorption		•	•	60
47. The possibility of multimolecular adsorption	•		٠	61
48. A derivation of the equation for the isotherm	•	•	•	61
49. A further simplification	•	•	•	65
50. The form at low values of p/p_0 .	•	•	•	66
51. The total shape		•		68
52. Ruling out the influence of active spots.	•			70
53. The form when $k = 1$ or less				71
54. Two examples	•		•	72
55. The form of the isotherm when $q \neq p_0$.	•	•		75
56. A Langmuir isotherm when $q \gg p_0$.		•	•	79
57. Conditions for multimolecular adsorption		•		81
58. The shape when $Q_a < Q_0$.	•	•		82
59. Restricted adsorption at $p = p_0$.		•	•	83
60. Criticisms	٠	•	•	84
61. Adsorption of a mixture of gases .	•	•		85
62. Adsorption from solutions	•	•		87
CHAPTER VI. IDEAL TWO-DIMENSIONAL GAS		•	•	90
63. Movements of the molecules during the time $ au$	•	• •	•	90
64. Spreading and wetting	•	•	•	90
65. Surface migration	•	•	•	93
66. The picture of a two-dimensional gas .	•	•	•	94
67. The hopping molecule	•			95

CONTENTS

68. 2	The energy of activation for sur	face mig	gration	•	•	•	98
69.]	Equilibrium between a two-dimer	nsionala	ndathre	e-dimen	sionalga	s	98
70. 5	The two-dimensional gaseous sta	ite and	the entr	opy of a	dsorptio	n	99
71.	Spontaneous spreading and entr	\mathbf{opy}	•	•			101
72.	Establishing a two-dimensional	gas on t	the surfa	ace of a	liquid	•	102
73. '	The two-dimensional pressure, <i>E</i>	ק	•	•	•	•	104
74.	F and the 'surface tension'	•	•	•	•		104
75.	Gibbs' adsorption equation	•	•	•		•	106
76.	A few examples of a linear relati	ionship .	F versus	p (or c)			107
77. '	The linear relationship F versus	p and	the line	ar part	of an ac	1 -	
	sorption isotherm .	•	٠	•		,	108
	The ideal gas law .	•	•	•	•	•	109
	The molar area and the magnitu				•	•	110
	Evaluation of the entropy of ad				ntal dat	a	112
	The standard state and the heat	t of adso	$\mathbf{orption}$	•	•	•	115
	The various modes of motion	•	•	•	•	•	117
83.	The vibration of the adsorbed m	olecule	and the	constan	it τ_0	•	121
	ER VII. NON-IDEAL TWO-I		SIONAI	GASE	S: TWO).	
	IMENSIONAL CONDENSATI		(•	•	•	•	123
84.	A two-dimensional pressure F	corresp	onding	to the l	Langmu	ir	100
	adsorption isotherm .	•	•	•	•	•	123
	Introducing the 'surface area co			•	•	٠	124
	A wrong way to derive the Lan				•	•	124
87.	Relations between the Langmui of state	r equati	on and	volmer s	equatio	on	125
00	Mutual attraction forces	•	•	•	•	•	127
	FA versus F diagrams .	•	•	•	•	•	128
	Schofield and Rideal's equation	•	•		•	•	131
	The two-dimensional van der W		nation	•	•	•	132
	The correction term a_2 .	aans oq	uation	•	•	•	133
	Two-dimensional condensation $]$	• nhenom	• ong	•	•		134
	The two-dimensional saturation	-		and the	spreadir	• • •	101
94.	force, F_s	· prossu		·		•6	138
95.	Other two-dimensional phases						140
	Critical phenomena .						141
	Non-ideal two-dimensional gase	s on sol	id surfac	es			143
	Experimental evidence .						144
	The two-dimensional critical ter	nperatu	re				145
	The relations of a_2 and b_2 with a_2						146
	Numerical values for light gases						148
	Values of a_2 and b_2 simulating t		viour of	an idea	l gas		149
	Heavier gases					•	150
	LICHTICI EUROD · · ·	-	-				

ix

CO	NJ	ГE	N'	гs

104.	Anisotropic molecules; orient	tation		•			150
105.	Nitrogen as an example.		•	•		•	153
106.	Influence of orientation on th	ne two-di	mensi	onal critic	al tem	pera-	
	ture	•	•	•		•	154
107.	Dipoles and the two-dimension	onal criti	cal ter	nperature		•	155
108.	A further examination of th	ne pheno	menor	n of two-	limens	ional	
	condensation	•	•	•	•	•	157
	The influence of temperature				lensati	ion.	161
110.	The influence of the nature o	f the ads	orbent	•	•	•	168
0	TER VIII. THE ADSORPT	ION TSO	ידנדניי	י זאז זאס	ישדי מ	AST	
	F TWO-DIMENSIONAL CO				ne (AOL	170
	Adsorption isotherm with var				•	•	170
	The choice of σ_0 .		als at	ilaction i	1005	•	172
	Relations between the Lang	• muin ad	• 	• in insther	•	I tha	172
115.	equations of state .	ginuir au	sorput		in and	1 0110	174
114	A reduced form of the isother	• rm equat	ion an	d its cons	tants		178
	Various curves showing the c	_					180
	The pressure at which two-di					•	184
	Co-operation of adsorption fo					•	185
	Critical phenomena .	icos and	muon	monocular	101005	•	186
	A few examples of two-dim	ensional	• aonde	• mention c	• •f adar	wheel	100
115.	substances		conue		n auso		188
120.	Composite surfaces .						190
	Comparison with experiments	al data					194
	Gradual variation of adsorpti						195
	Variation of the heat of ad			the two-	limens	ional	
140.	critical temperature .						197
	-						
	TER IX. MULTIMOLECULA	R ADSC	RPTI	ON AND	CONI)EN-	
	ATION	•	•	•	•	•	200
	Forces emanating from a first		cular	layer	•	•	200
	Adsorbing a second, third, etc		•	•	٠	•	201
	Multimolecular adsorption on	a super-	critica	l layer	•	•	204
	Influence of orientation .	•	•	•		•	205
	Combined steps	•	•	•	•	•	208
129.	Influence of capillaries .	•	•	•	•	•	210
	An attempt to derive a mathe			lation	•	•	213
131.	The structure of the multimo	lecular la	yer	•	•	•	214
132.	A physical picture of multime	olecular a	dsorp	tion.	•	•	217
133.	Crystal growth		•	•	•	•	219
134.	The formation of nuclei.	•		•	•	•	221
135.	Two-dimensional supersatura	tion		•	•		222
136.	Hysteresis caused by supersat	turation					224

x

CONTENTS				xi
CHAPTER X. SOME EFFECTS OF CAPILLAR	RIES		•	225
137. The rate of diffusion into capillaries .	•	•	•	225
138. Diffusion through surface migration .			·	226
139. Swelling and the two-dimensional pressure		•	•	230
140. Penetration into the material				231
141. Hysteresis caused by swelling phenomena	•			231
142. 'Activated adsorption'	,			233
143. Final remarks	•	•	•	233
INDEX	•	•		236