### Contents

EDITORS'	FOREV	VORD	• •	•	•	•	•	•	•	•	•	·	•	•	•	•	•	•	v
PREFACE	то тн	e eno	GLISH	EDĮT	ION	•	•		•.	•	•		•	•	•	•	•		ix
PREFACE	то тн	E FIR	ST RI	JSSIAN	ED	ITIO	N		•	•			•		•	•	•	•	xi
PREFACE	то тн	e sec	OND	RUSSI	AN I	EDIT	ION		•		•	•	•	•	•	•	•	•	xv
CONDENS	ED CON	TEN	rs of	VOLU	JME	п	•	•	•	•	•	•	•	•	•	•	•	•	xxiii

# I. Elements of gasdynamics and the classical theory of shock waves

	The equations of gasdynamics				
§2.	Lagrangian coordinates				
§3.	Sound waves				
§4.					1
§5.	Characteristics		•		1
§6.	Plane isentropic flow. Riemann invariants				1
§7.	Plane isentropic gas flow in a bounded region				2
§8.	Simple waves				2
§9.	Distortion of the wave form in a traveling wave of finite amplitude.				
	Some properties of simple waves				2
§10.	The rarefaction wave				3
§11.	The centered rarefaction wave as an example of self-similar gas				
	motion			•	3
§12.	On the impossibility of the existence of a centered compression way	ve			4
					4
2.	Shock waves				-
	Shock waves Introduction to the gasdynamics of shock waves				4
 §13.	Introduction to the gasdynamics of shock waves		•	•	
\$13. §14.	Introduction to the gasdynamics of shock waves	•		•	2
§13. §14. §15.	Introduction to the gasdynamics of shock waves			•	2
§13. §14. §15.	Introduction to the gasdynamics of shock waves				4
§13. §14. §15. §16.	Introduction to the gasdynamics of shock waves Hugoniot curves Shock waves in a perfect gas with constant specific heats Geometric interpretation of the laws governing compression shocks				
§13. §14. §15. §16. §17.	Introduction to the gasdynamics of shock waves Hugoniot curves Shock waves in a perfect gas with constant specific heats Geometric interpretation of the laws governing compression shocks Impossibility of rarefaction shock waves in a fluid with normal				

0	Equations of one-dimensional gas flow
0	Remarks on the second viscosity coefficient
0	Remarks on the absorption of sound
<i>§25</i> .	The structure and thickness of a weak shock front
4.	Various problems
§24.	Propagation of an arbitrary discontinuity
§25.	Strong explosion in a homogeneous atmosphere
§26.	Approximate treatment of a strong explosion
§27.	Remarks on the point explosion with counterpressure
§28.	Sudden isentropic expansion of a spherical gas cloud into vacuum
§29.	Conditions for the self-similar sudden expansion of a gas cloud into
	vacuum

§1.	Introduction and basic concepts
§2.	Mechanisms of emission, absorption, and scattering of light in gases 111
§3.	Equilibrium radiation and the concept of a perfect black body 115
§4.	Induced emission
§4a.	Induced emission of radiation in the classical and quantum theories
	and the laser effect
§5.	The radiative transfer equation
§6.	Integral expressions for the radiation intensity
§7.	Radiation from a plane layer
§8.	The brightness temperature of the surface of a nonuniformly heated
	body
§9.	Motion of a fluid taking into account radiant heat exchange 141
§10.	The diffusion approximation
§11.	The "forward-reverse" approximation
§12.	Local equilibrium and the approximation of radiation heat conduction 151
§13.	Relationship between the diffusion approximation and the radiation
	heat conduction approximation
§14.	Radiative equilibrium in stellar photospheres
§15.	Solution to the plane photosphere problem
§16.	Radiation energy losses of a heated body
§17.	Hydrodynamic equations accounting for radiation energy and
	pressure and radiant heat exchange
§18.	The number of photons as an invariant of the classical
	electromagnetic field
TTT	Thermodynamic properties of same at high terrorectory
Ш.	Thermodynamic properties of gases at high temperatures

1.	Gas of n	oni	nte	era	ctir	ıg j	par	•tic	les							176
§1.	Perfect ga particles					-								•	•	176

xviii

§2.	Calculation of thermodynamic functions using partition functions 1	79
§3.	Dissociation of diatomic molecules	83
§4.	Chemical reactions	88
§5.	Ionization and electronic excitation	92
§6.	The electronic partition function and the role of the excitation	
	energy of atoms	98
§7.	Approximate methods of calculation in the region of multiple	
-	ionization	01
§8.	Interpolation formulas and the effective adiabatic exponent	207
§9.	The Hugoniot curve with dissociation and ionization	09
§10.	The Hugoniot relations with equilibrium radiation	213
2.	Gases with Coulomb interactions 2	21:
	- ···· + • ··· + • ··· · · · · · · · · ·	
0	Rarefied ionized gases	
	Dense gases. Elements of Fermi-Dirac statistics for an electron gas 2	218
§13.	The Thomas–Fermi model of an atom and highly compressed cold	
	materials	22
§14.	Calculation of thermodynamic functions of a hot dense gas by the	
	Thomas–Fermi method	229
	•	
IV	Shock tubes	
IV.	Shock tubes	
		23
§1.	The use of shock tubes for studying kinetics in chemical physics 2	
§1. §2.	The use of shock tubes for studying kinetics in chemical physics 2 Principle of operation	234
§1. §2. §3.	The use of shock tubes for studying kinetics in chemical physics       .       <	234 236
§1. §2. §3. §4.	The use of shock tubes for studying kinetics in chemical physics 2 Principle of operation	234 23( 239

## V. Absorption and emission of radiation in gases at high temperatures

§1.	Introduction. Types of electronic transitions	•	•	•	246
1.	Continuous spectra				248
§2.	Bremsstrahlung emission from an electron in the Coulomb field of				
	an ion				248
§2a.	. Bremsstrahlung emission from an electron scattered by a neutral				
	atom		•		255
§3.	Free-free transitions in a high-temperature ionized gas	•			258
§4.	Cross section for the capture of an electron by an ion with the				
	emission of a photon	•	•		261
§5.	Cross section for the bound-free absorption of light by atoms				
	and ions	•			264
§6.	Continuous absorption coefficient in a gas of hydrogen-like atoms	• .			269
§7.	Continuous absorption of light in a monatomic gas in the singly				
	ionized region	•	•		272
§8.	Radiation mean free paths for multiply ionized gas atoms	•			277

§8a.	Absorption of light in a weakly ionized gas	•	. 28
<b>2.</b>	Atomic line spectra		28
	Classical theory of spectral lines		. 28
		•	. 28
	The absorption spectrum of hydrogen-like atoms. Remarks on the	•	. 20
<b>911</b> .	effect of spectral lines on the Rosseland mean free path		. 29
812	Oscillator strengths for the continuum. The sum rule	•	. 29
	Radiative emission in spectral lines	•	. 30
-		•	• 50
	Molecular band spectra		30
	Energy levels of diatomic molecules	•	. 30
	Structure of molecular spectra	•	. 30
			. 31
	Probability of molecular transitions with the emission of light		
§18.	Light absorption coefficient in lines	•	. 32
§19.	Molecular absorption at high temperatures	•	. 32
§20.	More exact calculation of the molecular absorption coefficient at		
	high temperatures	•	. 32
4.	Air		3
§21.	Radiative properties of high-temperature air		. 3
	Breakdown		. 34
VI.	· · · ·	•	
	Molecular gases		3
	-		-
§1.	Establishment of thermodynamic equilibrium	•	. 3
	Excitation of molecular rotations	·	. 3
		•	
		•	. 3
§5.	Rate equation for dissocation of diatomic molecules and the		
~	relaxation time	•	. 3
§6.	Atom recombination rates and dissociation rates for diatomic		
	molecules	•	. 3
	Chemical reactions and the activated complex method	•	. 3
§8.	Oxidation of nitrogen	•	. 3
§9.	Rate of formation of nitrogen dioxide at high temperatures	·	. 3
2.	Ionization and recombination. Electronic		
	Initation and reconvention. Electronic		
	excitation and deexcitation		3
810	excitation and deexcitation		
		•	3 . 3 . 3

XX

15. Ionization and excitation by heavy particle collisions	§12.	Excitation of atoms from the ground state by electron impact.
14. Impact transitions between excited states of an atom		Deexcitation
14. Impact transitions between excited states of an atom	§13.	Ionization of excited atoms by electron impact
15. Ionization and excitation by heavy particle collisions	§14.	
16. Photoionization and photorecombination       402         17. Electron-ion recombination by three-body collisions (elementary theory)       406         18. A more rigorous theory of recombination by three-body collisions       406         19. Ionization and recombination in air       413 <b>8. Plasma</b> 416         20. Relaxation in a plasma       416         CITED REFERENCES       412         Appendix:       Some often used constants, relations between UNITS, AND FORMULAS       441         Author INDEX       447	§15.	
<ul> <li>17. Electron-ion recombination by three-body collisions (elementary theory)</li> <li>17. Electron-ion recombination by three-body collisions</li> <li>18. A more rigorous theory of recombination by three-body collisions</li> <li>19. Ionization and recombination in air</li> <li>19. Ionization and recombination in air</li> <li>10. A more rigorous theory of recombination in air</li> <li>10. A more rigorous theory of recombination by three-body collisions</li> <li>11. A more rigorous theory of recombination by three-body collisions</li> <li>11. A more rigorous theory of recombination by three-body collisions</li> <li>12. A more rigorous theory of recombination in air</li> <li>13. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombination in air</li> <li>14. A more rigorous theory of recombi</li></ul>		
theory)		
18. A more rigorous theory of recombination by three-body collisions       408         19. Ionization and recombination in air       413         8. Plasma       416         20. Relaxation in a plasma       416         CITED REFERENCES       416         CITED REFERENCES       422         Appendix:       Some often used constants, relations between         UNITS, AND FORMULAS       441         Author index       447	51/1	
19. Ionization and recombination in air       413 <b>8. Plasma</b> 416         20. Relaxation in a plasma       416         CITED REFERENCES       416         CITED REFERENCES       422         Appendix:       Some often used constants, relations between         UNITS, AND FORMULAS       441         Author index       447	818	
B. Plasma       416         20. Relaxation in a plasma       416         CITED REFERENCES       416         CITED REFERENCES       422         Appendix:       Some often used constants, relations between UNITS, AND FORMULAS       421         Author index       441		
20. Relaxation in a plasma	ş17.	
CITED REFERENCES	3.	Plasma 416
Appendix:       Some often used constants, relations between         Units, and formulas	§20.	Relaxation in a plasma
UNITS, AND FORMULAS		Cited references
UNITS, AND FORMULAS		
UNITS, AND FORMULAS		Appendix: Some often used constants, relations between
Author index $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $.$		
		SUBJECT INDEX $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$ $$ 452