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Mechanics and Thermodynamics

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Preface

The present textbook represents the first part of a four-volume series on experimental Physics. It covers the field of Mechanics and Thermodynamics. One of its goal is to illustrate, that the explanation of our world and of all natural processes by Physics is always the description of models of our world, which are formulated by theory and proved by experiments. The continuous improvement of these models leads to a more detailled understanding of our world and of the processes that proceed in it.

The representation of this textbook starts with an introductory chapter giving a brief survey of the history and development of Physics and its present relevance for other sciences and for technology. Since experimental Physics is based on measuring techniques and quantitative results, a section discusses basic units, techniques for their measurements and the accuracy and possible errors of measurements.

In all further chapters the description of the real world by successively refined models is outlined. It begins with the model of a point mass, its motion under the action of forces and its limitations. Since the description of moving masses requires a coordinate system, the transformation of results obtained in one system to another system moving against the first one is described. This leads to the theory of special relativity, which is discussed in Chap. 3. The next chapter upgrades the model of point masses to spatially extended rigid bodies, where the spatial extension of a body cannot be ignored but influences the results. Then the deformation of bodies under the influence of forces is discussed and phenomena caused by this deformation are explained. The existence of different phases (solid, liquid and gaseous) and their relation with external influences such as temperature and pressure, are discussed.

The properties of gases and liquids at rest and the effects caused by streaming gases and liquids are outlined in Chap. 7 and 8.

Many insights in natural phenomena, in particular in the area of atomic and molecular physics could only be explored after sufficiently good vacua could be realized. Therefore Chap. 9 discusses briefly the most important facts of vacuum physics, such as the realization and measurement of evacuated volumina.

Thermodynamics governs important aspects of our life. Therefore an extended chapter about definitions and measuring techniques for temperatures, heat energy and phase transitions should emphazise the importance of thermodynamics. The three principle laws ot thermodynamics and their relevanve for energy transformation and dissipation are discussed.

Chapter 11 deals with oscillations and waves, a subject which is closely related to acoustics and optics.

While all foregoing chapters discuss classical physics which had been developed centuries ago, Chap. 12 covers a modern subject, namely nonlinear phenomena and chaos theory. It should give a feeling for the fact, that most phenomena in classical physics can be described only approximately by linear equations. A closer inspection shows that the accurate description demands nonlinear equations with surprising solutions.

A description of phenomena in physics requires some minimum mathematical knowledge. Therefore a brief survey about vector algebra and vector analysis, about complex numbers and different coordinate systems is provided in the last chapter.

A real understanding of the subjects covered in this textbook can be checked by solving problems, which are given at the end of each chapter. A sketch of the solutions can be found at the end of the book.

For further studies and a deeper insight into special subjects some selected literature is given at the end of each chapter.

The author hopes that this book can transfer some of his enthusiasm for the fascinating field of physics. He is grateful for any comments and suggestions, also for hints to possible errors. Every e-mail will be answered as soon as possible.

Several people have contributed to the realization of this book. Many thanks go the Dr. Schneider and Ute Heuser, Springer Verlag Heidelberg, who supported and encouraged the authors over the whole period needed for translating this book from a German version. Nadja Kroke and her team (le-tex publishing services GmbH) did a careful job for the layout of the book and induced the author to improve ambiguous sentences or unclear hints to equations or figures. I thank them all for their efforts.

Last but not least I thank my wife Harriet, who showed much patience when her husband disappeared into his office for the work on this book.

Kaiserslautern, December 2016 Wolfgang Demtröder

Contents

1 Introduction and Survey 1

1.1 The Importance of Experiments 2

1.2 The Concept of Models in Physics 3

1.3 Short Historical Review 5
1.3.1 The Natural Philosophy in Ancient Times 5
1.3.2 The Development of Classical Physics 7
1.3.3 Modern Physics 10

1.4 The Present Conception of Our World 11

1.5 Relations Between Physics and Other Sciences 14
1.5.1 Biophysics and Medical Physics 14
1.5.2 Astrophysics 15
1.5.3 Geophysics and Meteorology 15
1.5.4 Physics and Technology 15
1.5.5 Physics and Philosophy 16

1.6 The Basic Units in Physics, Their Standards and Measuring Techniques 16
1.6.1 Length Units 17
1.6.2 Measuring Techniques for Lengths 19
1.6.3 Time-Units 20
1.6.4 How to measure Times 23
1.6.5 Mass Units and Their Measurement 23
1.6.6 Molar Quantity Unit 24
1.6.7 Temperature Unit 24
1.6.8 Unit of the Electric Current 25
1.6.9 Unit of Luminous Intensity 25
1.6.10 Unit of Angle 25

1.7 Systems of Units 26

1.8 Accuracy and Precision; Measurement Uncertainties and Errors 27
1.8.1 Systematic Errors 27
1.8.2 Statistical Errors, Distribution of Experimental Values, Mean Values 27
1.8.3 Variance and its Measure 29
1.8.4 Error Distribution Law 29
1.8.5 Error Propagation 31
1.8.6 Equalization Calculus 32

Summary 34

Problems 35

References 35

2 Mechanics of a Point Mass 39

2.1 The Model of the Point Mass; Trajectories 40

2.2 Velocity and Acceleration 41

2.3 Uniformly Accelerated Motion . . . 42
2.3.1 The Free Fall . . . 43
2.3.2 Projectile Motion . . . 43
2.4 Motions with Non-Constant Acceleration . . . 44
2.4.1 Uniform Circular Motion . . . 44
2.4.2 Motions on Trajectories with Arbitrary Curvature . . . 45
2.5 Forces . . . 47
2.5.1 Forces as Vectors; Addition of Forces . . . 47
2.5.2 Force-Fields . . . 48
2.5.3 Measurements of Forces; Discussion of the Force Concept . . . 50
2.6 The Basic Equations of Mechanics . . . 51
2.6.1 The Newtonian Axioms . . . 51
2.6.2 Inertial and Gravitational Mass . . . 52
2.6.3 The Equation of Motion of a Particle in Arbitrary Force Fields . 53
2.7 Energy Conservation Law of Mechanics . . . 56
2.7.1 Work and Power . . . 56
2.7.2 Path-Independent Work; Conservative Force-Fields . . . 58
2.7.3 Potential Energy . . . 59
2.7.4 Energy Conservation Law in Mechanics . . . 61
2.7.5 Relation Between Force Field and Potential . . . 62
2.8 Angular Momentum and Torque . . . 63
2.9 Gravitation and the Planetary Motions . . . 64
2.9.1 Kepler's Laws . . . 64
2.9.2 Newton's Law of Gravity . . . 66
2.9.3 Planetary Orbits . . . 66
2.9.4 The Effective Potential . . . 68
2.9.5 Gravitational Field of Extended Bodies . . . 69
2.9.6 Measurements of the Gravitational Constant G . . . 71
2.9.7 Testing Newton's Law of Gravity . . . 72
2.9.8 Experimental Determination of the Earth Acceleration g . . . 74
Summary . . . 76
Problems . . . 77
References . . . 79
3 Moving Coordinate Systems and Special Relativity . . . 81
3.1 Relative Motion . . . 82
3.2 Inertial Systems and Galilei-Transformations . . . 82
3.3 Accelerated Systems; Inertial Forces . . . 83
3.3.1 Rectilinear Accelerated Systems . . . 83
3.3.2 Rotating Systems . . . 85
3.3.3 Centrifugal- and Coriolis-Forces . . . 86
3.3.4 Summary . . . 89
3.4 The Constancy of the Velocity of Light . . . 89
3.5 Lorentz-Transformations . . . 90
3.6 Theory of Special Relativity . . . 92
3.6.1 The Problem of Simultaneity . . . 92
3.6.2 Minkowski-Diagram . . . 93
3.6.3 Lenght Scales . . . 93
3.6.4 Lorentz-Contraction of Lengths . . . 94
3.6.5 Time Dilatation . . . 96

3.6.6 The Twin-Paradox . . . 97
3.6.7 Space-time Events and Causality . . . 99

Summary . . . 100

Problems . . . 100

References . . . 101

4 Systems of Point Masses; Collisions . . . 103

4.1 Fundamentals . . . 104
4.1.1 Centre of Mass . . . 104
4.1.2 Reduced Mass . . . 105
4.1.3 Angular Momentum of a System of Particles . . . 105

4.2 Collisions Between Two Particles . . . 107
4.2.1 Basic Equations . . . 108
4.2.2 Elastic Collisions in the Lab-System . . . 109
4.2.3 Elastic Collisions in the Centre-of Mass system . . . 111
4.2.4 Inelastic Collisions . . . 113
4.2.5 Newton-Diagrams . . . 114

4.3 What Do We Learn from the Investigation of Collisions? . . . 115
4.3.1 Scattering in a Spherical Symmetric Potential . . . 115
4.3.2 Reactive Collisions . . . 118

4.4 Collisions at Relativistic Energies . . . 119
4.4.1 Relativistic Mass Increase . . . 119
4.4.2 Force and Relativistic Momentum . . . 120
4.4.3 The Relativistic Energy . . . 121
4.4.4 Inelastic Collisions at relativistic Energies . . . 122
4.4.5 Relativistic Formulation of Energy Conservation . . . 122

4.5 Conservation Laws . . . 123
4.5.1 Conservation of Momentum . . . 123
4.5.2 Energy Conservation . . . 124
4.5.3 Conservation of Angular Momentum . . . 124
4.5.4 Conservation Laws and Symmetries . . . 124

Summary . . . 125

Problems . . . 126

References . . . 127

5 Dynamics of rigid Bodies . . . 129

5.1 The Model of a Rigid Body . . . 130

5.2 Center of Mass . . . 130

5.3 Motion of a Rigid Body . . . 131

5.4 Forces and Couple of Forces . . . 132

5.5 Rotational Inertia and Rotational Energy . . . 133
5.5.1 The Parallel Axis Theorem (Steiner's Theorem) . . . 134

5.6 Equation of Motion for the Rotation of a Rigid Body . . . 136
5.6.1 Rotation About an Axis for a Constant Torque . . . 137
5.6.2 Measurements of rotational inertia; Rotary Oscillations About a Fixed Axis . . . 139
5.6.3 Comparison Between Translation and Rotation . . . 139

5.7 Rotation About Free Axes; Spinning Top . . . 139
5.7.1 Inertial Tensor and Inertial Ellipsoid . . . 140
5.7.2 Principal Moments of Inertia . . . 141
5.7.3 Free Rotational axes . . . 143
5.7.4 Euler's Equations . . . 144
5.7.5 The Torque-free Symmetric Top . . . 145
5.7.6 Precession of the Symmetric Top . . . 147
5.7.7 Superposition of Nutation and Precession . . . 148
5.8 The Earth as Symmetric Top . . . 149
Summary . . . 151
Problems . . . 151
References . . . 152
6 Real Solid and Liquid Bodies . . . 153
6.1 Atomic Model of the Different Aggregate States . . . 154
6.2 Deformable Solid Bodies . . . 155
6.2.1 Hooke's Law . . . 156
6.2.2 Transverse Contraction . . . 157
6.2.3 Shearing and Torsion Module . . . 158
6.2.4 Bending of a Balk . . . 159
6.2.5 Elastic Hysteresis; Energy of Deformation . . . 161
6.2.6 The Hardness of a Solid Body . . . 162
6.3 Static Liquids; Hydrostatics . . . 162
6.3.1 Free Displacement and Surfaces of Liquids . . . 162
6.3.2 Static Pressure in a Liquid . . . 163
6.3.3 Buoyancy and Floatage . . . 165
6.4 Phenomena at Liquid Surfaces . . . 166
6.4.1 Surface Tension . . . 166
6.4.2 Interfaces and Adhesion Tension . . . 168
6.4.3 Capillarity . . . 170
6.4.4 Summary of Section 6.4 . . . 171
6.5 Friction Between Solid Bodies . . . 171
6.5.1 Static Friction . . . 171
6.5.2 Sliding Friction . . . 172
6.5.3 Rolling Friction . . . 173
6.5.4 Significance of Friction for Technology . . . 174
6.6 The Earth as Deformable Body . . . 174
6.6.1 Ellipticity of the Rotating Earth . . . 175
6.6.2 Tidal Deformations . . . 175
6.6.3 Consequences of the Tides . . . 178
6.6.4 Measurements of the Earth Deformation . . . 179
Summary . . . 180
Problems . . . 181
References . . . 181
7 Gases . . . 183
7.1 Macroscopic Model . . . 184
7.2 Atmospheric Pressure and Barometric Formula . . . 185

7.3 Kinetic Gas Theory . . . 188
7.3.1 The Model of the Ideal Gas . . . 188
7.3.2 Basic Equations of the Kinetic Gas Theory . . . 189
7.3.3 Mean Kinetic Energy and Absolute Temperature . . . 190
7.3.4 Distribution Function . . . 190
7.3.5 Maxwell–Boltzmann Velocity Distribution . . . 191
7.3.6 Collision Cross Section and Mean Free Path Length . . . 195
7.4 Experimental Proof of the Kinetic Gas Theory . . . 196
7.4.1 Molecular Beams . . . 196
7.5 Transport Phenomena in Gases . . . 198
7.5.1 Diffusion . . . 198
7.5.2 Brownian Motion . . . 200
7.5.3 Heat Conduction in Gases . . . 201
7.5.4 Viscosity of Gases . . . 202
7.5.5 Summary of Transport Phenomena . . . 203
7.6 The Atmosphere of the Earth . . . 204
Summary . . . 206
Problems . . . 207
References . . . 208
8 Liquids and Gases in Motion; Fluid Dynamics . . . 209
8.1 Basic Definitions and Types of Fluid Flow . . . 210
8.2 Euler Equation for Ideal Liquids . . . 212
8.3 Continuity Equation . . . 212
8.4 Bernoulli Equation . . . 213
8.5 Laminar Flow . . . 216
8.5.1 Internal Friction . . . 216
8.5.2 Laminar Flow Between Two Parallel Walls . . . 218
8.5.3 Laminar Flows in Tubes . . . 219
8.5.4 Stokes Law, Falling Ball Viscometer . . . 220
8.6 Navier–Stokes Equation . . . 220
8.6.1 Vortices and Circulation . . . 221
8.6.2 Helmholtz Vorticity Theorems . . . 222
8.6.3 The Formation of Vortices . . . 223
8.6.4 Turbulent Flows; Flow Resistance . . . 224
8.7 Aerodynamics . . . 226
8.7.1 The Aerodynamical Buoyancy . . . 226
8.7.2 Relation between Dynamical and Flow Resistance . . . 227
8.7.3 Forces on a flying Plane . . . 228
8.8 Similarity Laws; Reynolds' Number . . . 228
8.9 Usage of Wind Energy . . . 229
Summary . . . 233
Problems . . . 234
References . . . 235
9 Vacuum Physics . . . 237
9.1 Fundamentals and Basic Concepts . . . 238
9.1.1 The Different Vacuum Ranges . . . 238
9.1.2 Influence of the Molecules at the Walls . . . 239

9.1.3 Pumping Speed and Suction Capacity of Vacuum Pumps 239
9.1.4 Flow Conductance of Vacuum Pipes 240
9.1.5 Accessible Final Pressure 241

9.2 Generation of Vacuum 241
9.2.1 Mechanical Pumps 242
9.2.2 Diffusion Pumps 244
9.2.3 Cryo- and Sorption-Pumps; Ion-Getter Pumps 246

9.3 Measurement of Low Pressures 247
9.3.1 Liquid Manometers 248
9.3.2 Membrane Manometer 248
9.3.3 Heat Conduction Manometers 249
9.3.4 Ionization Gauge and Penning Vacuum Meter 249
9.3.5 Rotating Ball Vacuum Gauge 250

Summary 251

Problems 251

References 252

10 Thermodynamics 253

10.1 Temperature and Amount of Heat 254
10.1.1 Temperature Measurements, Thermometer, and Temperature Scales 254
10.1.2 Thermal Expansion of Liquids and Solids 256
10.1.3 Thermal Expansion of Gases; Gas Thermometer 258
10.1.4 Absolute Temperature Scale 259
10.1.5 Amount of Heat and Specific Heat Capacity 260
10.1.6 Molar Volume and Avogadro Constant 261
10.1.7 Internal Energy and Molar Heat Capacity of Ideal Gases 261
10.1.8 Specific Heat of a Gas at Constant Pressure 262
10.1.9 Molecular Explanation of the Specific Heat 263
10.1.10 Specific Heat Capacity of Solids 264
10.1.11 Fusion Heat and Heat of Evaporation 265

10.2 Heat Transport 266
10.2.1 Convection 266
10.2.2 Heat Conduction 267
10.2.3 The Heat Pipe 271
10.2.4 Methods of Thermal Insulation 271
10.2.5 Thermal Radiation 273

10.3 The Three Laws of Thermodynamics 279
10.3.1 Thermodynamic Variables 279
10.3.2 The First Law of Thermodynamics 280
10.3.3 Special Processes as Examples of the First Law of Thermodynamics 281
10.3.4 The Second Law of Thermodynamics 282
10.3.5 The Carnot Cycle 283
10.3.6 Equivalent Formulations of the Second Law 286
10.3.7 Entropy 286
10.3.8 Reversible and Irreversible Processes 290
10.3.9 Free Energy and Enthalpy 291
10.3.10 Chemical Reactions 292
10.3.11 Thermodynamic Potentials; Relations Between Thermodynamic Variables 292
10.3.12 Equilibrium States 293
10.3.13 The Third Law of Thermodynamics 294
10.3.14 Thermodynamic Engines 295

10.4 Thermodynamics of Real Gases and Liquids . . . 299
10.4.1 Van der Waals Equation of State . . . 299
10.4.2 Matter in Different Aggregation States . . . 301
10.4.3 Solutions and Mixed States . . . 307
10.5 Comparison of the Different Changes of State . . . 309
10.6 Energy Sources and Energy Conversion . . . 309
10.6.1 Hydro-Electric Power Plants . . . 312
10.6.2 Tidal Power Stations . . . 312
10.6.3 Wave Power Stations . . . 313
10.6.4 Geothermal Power Plants . . . 313
10.6.5 Solar-Thermal Power Stations . . . 314
10.6.6 Photovoltaic Power Stations . . . 315
10.6.7 Bio-Energy . . . 316
10.6.8 Energy Storage . . . 316
Summary . . . 317
Problems . . . 318
References . . . 319
11 Mechanical Oscillations and Waves . . . 321
11.1 The Free Undamped Oscillator . . . 322
11.2 Mathematical Notations of Oscillations . . . 323
11.3 Superposition of Oscillations . . . 324
11.3.1 One-Dimensional Superposition . . . 324
11.3.2 Two-dimensional Superposition; Lissajous-Figures . . . 327
11.4 The Free Damped Oscillator . . . 328
11.4.1 $\gamma < \omega_0$, i. e. weak damping . . . 329
11.4.2 $\gamma > \omega_0$, i. e. strong Damping . . . 329
11.4.3 $\gamma = \omega_0$ (aperiodic limiting case) . . . 330
11.5 Forced Oscillations . . . 330
11.5.1 Stationary State . . . 331
11.5.2 Transient State . . . 333
11.6 Energy Balance for the Oscillation of a Point Mass . . . 333
11.7 Parametric Oscillator . . . 334
11.8 Coupled Oscillators . . . 335
11.8.1 Coupled Spring Pendulums . . . 335
11.8.2 Forced Oscillations of Two Coupled Oscillators . . . 338
11.8.3 Normal Vibrations . . . 339
11.9 Mechanical Waves . . . 339
11.9.1 Different Representations of Harmonic Plane Waves . . . 340
11.9.2 Summary . . . 341
11.9.3 General Description of Arbitrary Waves; Wave-Equation . . . 341
11.9.4 Different Types of Waves . . . 342
11.9.5 Propagation of Waves in Different Media . . . 344
11.9.6 Energy Density and Energy Transport in a Wave . . . 350
11.9.7 Dispersion; Phase- and Group-Velocity . . . 350
11.10 Superposition of Waves; Interference . . . 352
11.10.1 Coherence and Interference . . . 352
11.10.2 Superposition of Two Harmonic Waves . . . 353

11.11 Diffraction, Reflection and Refraction of Waves . . . 354
11.11.1 Huygens's Principle . . . 355
11.11.2 Diffraction at Apertures . . . 356
11.11.3 Summary . . . 358
11.11.4 Reflection and Refraction of Waves . . . 358

11.12 Standing Waves . . . 359
11.12.1 One-Dimensional Standing Waves . . . 359
11.12.2 Experimental Demonstrations of Standing Waves . . . 360
11.12.3 Two-dimensional Resonances of Vibrating Membranes . . . 361

11.13 Waves Generated by Moving Sources . . . 363
11.13.1 Doppler-Effect . . . 363
11.13.2 Wave Fronts for Moving Sources . . . 364
11.13.3 Shock Waves . . . 365

11.14 Acoustics . . . 366
11.14.1 Definitions . . . 366
11.14.2 Pressure Amplitude and Energy Density of Acoustic Waves . . . 367
11.14.3 Sound Generators . . . 368
11.14.4 Sound-Detectors . . . 368
11.14.5 Ultrasound . . . 369
11.14.6 Applications of Ultrasound . . . 370
11.14.7 Techniques of Ultrasonic Diagnosis . . . 371

11.15 Physics of Musical Instruments . . . 372
11.15.1 Classification of Musical Instruments . . . 372
11.15.2 Chords, Musical Scale and Tuning . . . 372
11.15.3 Physics of the Violin . . . 374
11.15.4 Physics of the Piano . . . 375

Summary . . . 376

Problems . . . 378

References . . . 379

12 Nonlinear Dynamics and Chaos . . . 381

12.1 Stability of Dynamical Systems . . . 383

12.2 Logistic Growth Law; Feigenbaum-Diagram . . . 386

12.3 Parametric Oscillator . . . 388

12.4 Population Explosion . . . 389

12.5 Systems with Delayed Feedback . . . 390

12.6 Self-Similarity . . . 391

12.7 Fractals . . . 392

12.8 Mandelbrot Sets . . . 393

12.9 Consequences for Our Comprehension of the Real World . . . 397

Summary . . . 397

Problems . . . 398

References . . . 399

13 Supplement . . . 401

13.1 Vector Algebra and Analysis . . . 402
13.1.1 Definition of Vectors . . . 402
13.1.2 Representation of Vectors . . . 402

13.1.3 Polar and Axial Vectors . . . 403
13.1.4 Addition and Subtraction of Vectors . . . 403
13.1.5 Multiplication of Vectors . . . 404
13.1.6 Differentiation of Vectors . . . 405
13.2 Coordinate Systems . . . 407
13.2.1 Cartesian Coordinates . . . 408
13.2.2 Cylindrical Coordinates . . . 408
13.2.3 Spherical Coordinates . . . 409
13.3 Complex Numbers . . . 410
13.3.1 Calculation rules of Complex Numbers . . . 410
13.3.2 Polar Representation . . . 411
13.4 Fourier-Analysis . . . 411
14 Solutions of the Problems . . . 413
14.1 Chapter 1 . . . 414
14.2 Chapter 2 . . . 414
14.3 Chapter 3 . . . 418
14.4 Chapter 4 . . . 420
14.5 Chapter 5 . . . 423
14.6 Chapter 6 . . . 425
14.7 Chapter 7 . . . 426
14.8 Chapter 8 . . . 429
14.9 Chapter 9 . . . 431
14.10 Chapter 10 . . . 433
14.11 Chapter 11 . . . 436
14.12 Chapter 12 . . . 441
Index . . . 445