

CONTENTS

Front End Papers

Periodic Table of the Elements; Fundamental Constants

Rear End Papers

Units and Symbols; Conversion Factors

Chapter 1 Introduction

What is physics? 2 □ The classical branches of physics 2 □ Our view of the universe 3 □ The relation of physics to other sciences 10 □ The experimental method 10

Chapter 2 Measurement and Units

Introduction 15 □ Measurement 15 □ Fundamental quantities and units 16 □ Density 20 □ Plane angles 21 □ Solid angles 22 □ Precision and accuracy 23 □ Measurement in the laboratory 25

Chapter 3 Vectors

Introduction 31 □ Concept of direction 31 □ Scalars and vectors 32 □ Addition of vectors 33 □ Components of a vector 36 □ Addition of several vectors 40 □ Application to kinematic problems 41 □ Scalar product 43 □ Vector product 46 □ Vector representation of an area 49

Chapter 4 Forces

Introduction 57 □ Composition of concurrent forces 57 □ Torque 58 □ Torque of several concurrent forces 60 □ Composition of forces applied to a rigid body 62 □ Composition of coplanar forces 63 □ Composition of parallel forces 64 □ Center of mass 66 □ Statics. Equilibrium of a particle 69 □ Statics. Equilibrium of a rigid body 70

PART 1 MECHANICS

Chapter 5 Kinematics

Introduction 84 □ Rectilinear motion: velocity 85 □ Rectilinear motion: acceleration 87 □ Vector representation of velocity and acceleration in rectilinear motion 89 □ Curvilinear motion: velocity 94 □ Curvilinear motion: acceleration 96 □ Motion under constant acceleration 98 □ Tangential and normal components of acceleration 101 □ Circular motion: angular velocity 104 □ Circular motion: angular acceleration 106 □ General curvilinear motion in a plane 108

Chapter 6 Relative Motion

Introduction 118 □ Relative velocity 118 □ Uniform relative translational motion 120 □ Uniform relative rotational motion 123 □ Motion relative to the earth 125 □ The Lorentz transformation 133 □ Transformation of velocities 136 □ Consequences of the Lorentz transformation 140

Chapter 7 Dynamics of a Particle

Introduction 152 □ The law of inertia 152 □ Linear momentum 154 □ Principle of conservation of momentum 154 □ Redefinition of mass 158 □ Newton's second and third laws; concept of force 159 □ Critique of the concept of force 161 □ Units of force 162 □ Frictional forces 165 □ Frictional forces in fluids 168 □ Systems with variable mass 171 □ Curvilinear motion 173 □ Angular momentum 178 □ Central forces 180 □ Equilibrium and rest 184

Chapter 8 Work and Energy

Introduction 196 □ Work 197 □ Power 200 □ Units of work and power 200 □ Kinetic energy 203 □ Work of a force constant in magnitude and direction 205 □ Potential energy 207 □ Conservation of energy of a particle 212 □ Rectilinear motion under conservative forces 214 □ Motion under conservative central forces 215 □ Discussion of potential energy curves 217 □ Nonconservative forces 221 □ The virial theorem for a single particle 224 □ Critique of the concept of energy 225

Chapter 9 Dynamics of a System of Particles

Introduction 233 □ Motion of the center of mass of a system of particles 233 □ Reduced mass 239 □ Angular momentum of a system of particles 242 □ Kinetic energy of a system of particles 247 □ Conservation of energy of a system of particles 248 □ Collisions 253 □ Many-particle systems: temperature 259 □ Many-particle systems: work 261 □ Many-particle systems: heat

263 □ Reformulation of the principle of conservation of energy for many-particle systems 264 □ The virial theorem for many particles 265 □ Equation of state of a gas 267 □ Fluid motion 271

Chapter 10 Dynamics of a Rigid Body

Introduction 286 □ Angular momentum of a rigid body 287 □ Calculation of the moment of inertia 290 □ Equation of motion for rotation of a rigid body 294 □ Kinetic energy of rotation 300 □ Gyroscopic motion 303

Chapter 11 High-Energy Dynamics

Introduction 317 □ Classical principle of relativity 317 □ Special principle of relativity 319 □ Momentum 320 □ Force 322 □ Energy 325 □ Transformation of energy and momentum 330 □ Transformation of force 332 □ Systems of particles 334 □ High-energy collisions 336

Chapter 12 Oscillatory Motion

Introduction 347 □ Kinematics of single harmonic motion 347 □ Force and energy in simple harmonic motion 351 □ Dynamics of simple harmonic motion 352 □ The simple pendulum 354 □ Compound pendulum 357 □ Superposition of two SHM: same direction, same frequency 359 □ Superposition of two SHM: same direction, different frequency 362 □ Superposition of two SHM: perpendicular directions 363 □ Coupled oscillators 367 □ Anharmonic oscillations 372 □ Damped oscillations 374 □ Forced oscillations 376 □ Impedance of an oscillator 380 □ Fourier analysis of periodic motion 382

PART 2 INTERACTIONS AND FIELDS

Chapter 13 Gravitational Interaction

Introduction 396 □ The law of gravitation 398 □ Inertial and gravitational mass 401 □ Gravitational potential energy 402 □ General motion under gravitational interaction 408 □ Gravitational field 413 □ Gravitational field due to a spherical body 419 □ Principle of equivalence 424 □ Gravitation and intermolecular forces 426

Appendix: Mathematical Relations; Tables A-3

Answers to Odd-Numbered Problems A-13

Index A-22