TABLE OF CONTENTS

CHAPTER 1 — INTRODUCTION

1. Historical Background of Motion 1
2. The Measurement of Time 6
3. Classical Motion 9
4. Pre-Relativistic Mechanics 13
5. A Digression on Scientific Method 18
Exercise 1 19

CHAPTER 2 — DERIVATION OF SPECIAL RELATIVITY

1. Einstein's Formulation of Special Relativity 21
2. Reformulation of Relativity 25
3. Length Contraction, Time Dilation and Simultaneity 26
4. The Velocity Addition Formulae 30
5. Three Dimensional Lorentz Transformations 31
Exercise 2 34

CHAPTER 3 — DIGRESSION INTO TENSOR THEORY

1. Invariant Quantities 39
2. Tensors 43

3. Coordinate Transformations 46
Exercise 3 51

CHAPTER 4 — THE FOUR-VECTOR FORMULATION OF SPECIAL RELATIVITY

1. The Four-Vector Formalism 53
2. The Lorentz Transformations in 4-Vectors 55
3. The Lorentz and Poincaré Groups 59
4. The Null Cone Structure 62
5. The Search for Absolutes – Proper Time 65
Exercise 4 67

CHAPTER 5 — APPLICATIONS OF SPECIAL RELATIVITY

1. Relativistic Kinematics 69
2. The Doppler Shift in Relativity 73
3. The Compton Effect 77
4. Particle Scattering 80
5. Binding Energy, Particle Production and Particle Decay 83
Exercise 5 89

CHAPTER 6 — ELECTROMAGNETISM IN SPECIAL RELATIVITY

1. Review of Electromagnetism 93
2. The Electric and Magnetic Field Intensities 94
3. The Electric Current 96
4. Maxwell's Equations and Electromagnetic Waves 98
5. The Four-Vector Formulation 99
6. The Maxwell Equations Again 103
Exercise 6 105

CHAPTER 7 — SPECIAL RELATIVITY WITH SMALL ACCELERATIONS

1. Some 'Paradoxes' in Special Relativity 107
2. The Range of Validity of Special Relativity 111
3. The Gravitational Red-Shift 112
4. Gravitational Deflection of Light 113
5. Four-Vector Acceleration and Force 115
6. Restatement of the Principle of Special Relativity 119
7. Change of Metric Due to Acceleration 119

Exercise 7 122

INDEX 125