

Table contents

1	Preface	3
2	A review of quantum mechanics	4
2.1	Introduction	4
2.2	Wave modeling	4
2.3	Schrödinger equation	5
2.4	Harmonic oscillator	6
2.5	Pauli equation	6
3	Exercises	7
4	A review of special relativity	8
4.1	Overview of the laws of electromagnetism	8
4.1.1	Maxwell equations	8
4.1.2	Vector and scalar potentials	10
4.2	Vector analysis in Minkowski space	11
4.2.1	Quadri-divergence and quadri-gradient	11
4.2.2	Quad-vector current density	12
4.2.3	Quad-vector potential	13
4.2.4	Electromagnetic field tensor	13
4.2.5	Change of variable	15
5	Exercises	18
6	Symmetry and invariance	19
6.1	Definition	19
6.2	Types of transformations	19
6.2.1	Geometric transformations	19
6.2.2	Internal transformations	20
6.2.3	Internal geometric transformations	20
7	Exercises	21

	2
8 Klein-Gordon equation	22
8.1 Introduction	22
8.2 Quadri-vectors in field theory.	23
8.3 Free Klein-Gordon equation	24
8.4 Invariance of the free Klein-Gordon equation under gauge transformation	26
8.5 Solutions to the free Klein-Gordon equation	26
8.6 Physical interpretation of solutions to the free Klein-Gordon equation	28
9 Klein-Gordon equation in the presence of an external electromagnetic field	30
9.1 invariance of the Klein-Gordon equation under the presence of an external electro- magnetic field through gauge transformation	31
9.2 Klein-Gordon equation current in the presence of an external electromagnetic field	31
10 Exercises	33
11 Somme References	35