

Contents

<b>Preface</b>	xi
<b>1 Introduction</b>	1
Classical mechanics describes how ordinary-sized things behave. Quantum mechanics describes how atomic-sized things behave.	
<b>2 Classical Magnetic Needles</b>	5
In classical mechanics, a compass needle behaves like a “magnetic arrow” that obeys certain rules.	
<b>3 The Stern–Gerlach Experiment</b>	13
Experiments show that atomic-sized magnetic needles do not behave exactly like arrows.	
<b>4 The Conundrum of Projections; Repeated Measurements</b>	21
In fact, atomic-sized magnetic needles can’t behave like arrows at all! Repeated measurement experiments suggest that only probabilities, not certainties, can be predicted in quantum mechanics.	
<b>5 Probability</b>	31
An understanding of probability is necessary for quantum mechanics and important for day-to-day life.	
<b>6 The Einstein–Podolsky–Rosen Paradox</b>	38
The probabilistic character of quantum mechanics, suggested previously, is here proved.	
<b>7 Variations on a Theme by Einstein</b>	49
Two more proofs, intellectual descendants of the Einstein–Podolsky–Rosen argument. (This chapter is optional.)	

x	<i>Contents</i>
8	<b>Optical Interference</b> 57
	Atomic-sized things don't behave in the familiar classical way. But how do they behave? Light provides a clue, in that light from two sources can add up to produce — not more light — but darkness.
9	<b>Quantal Interference</b> 64
	We design an apparatus with two routes through which an atom may pass from the input to the output. If the atom must pass through one route, then the probability of passage is $\frac{1}{4}$ . If it must pass through the other route, then the probability of passage is $\frac{1}{4}$ . But if it may pass through either route, then the probability of passage is ... zero!
10	<b>Amplitudes</b> 76
	Quantal interference is described using an abstract entity called “amplitude”.
11	<b>Working with Amplitudes</b> 86
	Amplitude is represented mathematically by an arrow in a plane. Amplitude is associated with a process, not with a particle.
12	<b>Two-Slit Inventions</b> 94
	Variations on the quantal interference experiment drive home the point that “the atom takes both routes”.
13	<b>Quantum Cryptography</b> 98
	Quantum mechanics invites deep thought about the nature of reality and the character of science. But on the practical level, it also allows the construction of an unbreakable code. (This chapter is optional.)
14	<b>Quantum Mechanics of a Bouncing Ball</b> 103
	The quantal rules for amplitudes, when applied to an ordinary-sized ball moving through space, give the same common-sense result as classical mechanics — unless we trick the ball!
15	<b>The Wavefunction</b> 113
	How does an atom behave when it has no position? How can humans visualize this behavior?
	<b>Appendix A: A Brief History of Quantum Mechanics</b> 119
	<b>Appendix B: Putting Weirdness to Work</b> 133
	<b>Appendix C: Sources</b> 138
	<b>Appendix D: General Questions</b> 141
	<b>Appendix E: Bibliography</b> 145
	<b>Appendix F: Skeleton Answers for Selected Problems</b> 149
	<b>Index</b> 151