Contents

About the Author xvii

Introduction 1
Background 1
This Book 1
The Scientific Approach 2
Recording and Processing Uncertainties 3
Using a Spreadsheet 3
Controlling the Simulations 3
Thanks 4

1 Millikan's Oil Drop Experiment 5
Introduction 5
The Objective 6
The Apparatus 6
The Variables 8
The Physics 8
The Method 9
The Simulation 10
The Results 13
Further Discussion 14

2 Planck's Constant 15
Introduction 15
The Objective 16
The Apparatus 16
The Circuit 17
The Variables 18
The Physics 18
The Method 19
The Simulation 20
The Results 20
Further Discussion 22

3 Rutherford's Gold Foil Experiment 23
Introduction 23
The Objective 25
The Apparatus 25
The Variables 26
The Physics 26

The Method 27
The Simulator 27
The Results 28
Further Discussion 28

4 Measuring the Acceleration Due to Gravity 29
Introduction 29
The Objective 31
The Apparatus 31
The Variables 31
The Physics 32
The Method 32
The Simulation 32
The Results 33
Further Discussion 34

5 Average Velocity Using an AirTrack 37
Introduction 37
The Objective 38
The Apparatus 38
The Variables 38
The Physics 38
The Method 39
The Simulation 40
The Results 43
Further Discussion 44

6 Determining Acceleration Using an AirTrack 45
Introduction 45
The Objective 45
The Apparatus 45
The Variables 45
The Physics 46
The Method 46
The Simulation 47
The Results 48
Further Discussion 49

7 Confirmation of Newton's Second Law 51
Introduction 51
The Objective 52
The Apparatus 52
The Variables 53
The Physics 53
The Method 53
The Simulation 54

The Results 54
Further Discussion 54

8 Showing Conservation of Energy Using an AirTrack 55
Introduction 55
The Objective 55
The Apparatus 55
The Variables 55
The Physics 56
The Method 56
The Simulation 57
The Results 59
Further Discussion 59

9 Conservation of Momentum in an Inelastic Collision Using an AirTrack 61
Introduction 61
Objective 61
The Apparatus 61
The Variables 61
The Physics 62
The Method 62
The Simulation 63
The Results 64
Further Discussion 64

10 Hooke's Law 65
Introduction 65
The Objective 65
The Apparatus 66
The Variables 66
The Physics 67
The Method 67
The Simulator 67
The Results 68
Further Discussion 68

11 Young's Modulus 69
Introduction 69
The Objective 69
The Apparatus 69
The Variables 69
The Physics 70
The Method 70
The Simulator 70
The Results 71
Further Discussion 71

12 Velocity of Rifle Shell Using a Ballistic Balance 73
Introduction 73
The Objective 74
The Apparatus 74
The Variables 74
The Physics 75
The Method 76
The Simulation 77
The Results 77
Further Discussion 77

13 Simple Pendulum 79
Introduction 79
The Objective 79
The Apparatus 79
The Variables 81
The Physics 81
The Method 82
The Simulation 82
The Results 84
Further Discussion 85

14 Simple Harmonic Motion Using a Mass-Spring System 87
Introduction 87
The Objective 87
The Apparatus 87
The Variables 88
The Physics 88
The Method 91
The Simulation 91
The Results 93
Further Discussion 93

15 Capacitor Charge and Discharge 95
Introduction 95
Objective 95
The Apparatus 95
The Circuit 97
The Physics 98
Method 98
The Simulation 99
The Results 101
Further Discussion 102

16 The Internal Resistance of a Dry Cell 103
Introduction 103
The Objective 103

The Apparatus 103
The Circuit 104
The Variables 105
The Physics 105
The Method 105
The Simulation 106
The Results 106
Further Discussion 106

17 The IV Characteristics of a Diode 107
Introduction 107
Objective 108
The Apparatus 108
The Circuit 109
The Variables 110
Method 110
The Simulation 110
The Results 110
Further Discussion 110

18 The IV Characteristics of a Filament Lightbulb 111
Introduction 111
The Objective 111
The Apparatus 111
The Variables 112
The Circuit 112
The Method 112
The Simulation 113
The Results 114
Further Discussion 114

19 The Resistivity of Constantan 115
Introduction 115
Objective 115
The Apparatus 115
The Circuit 116
The Variables 117
The Physics 117
The Method 117
The Simulation 117
The Results 119
Further Discussion 119

20 Resistors in Series and Parallel 121
Introduction 121
Objective 121
The Apparatus 121

The Variables 122
The Physics 122
The Method 123
The Simulation 125
The Results 126
Further Discussion 126

21 Heat Transfer 127
Introduction 127
The Objective 127
The Apparatus 128
The Variables 128
The Physics 128
The Method 129
The Simulation 129
The Results 129
Further Discussion 129

22 Boyle's Law 131
Introduction 131
The Objective 133
The Apparatus 133
The Variables 134
The Physics 134
The Method 135
The Simulation 135
The Results 136
Further Discussion 136

23 Charles's Law 137
Introduction 137
The Objective 137
The Apparatus 137
The Variables 138
The Physics 138
The Method 138
The Simulation 139
The Results 140
Further Discussion 141

24 Mechanical Equivalent of Heat 143
Introduction 143
The Apparatus 144
The Variables 144
The Physics 146
The Method 146

The Simulation 146
The Results 148
Further Discussion 148

25 Specific Heat Capacity of Brass 149
Introduction 149
The Objective 149
The Apparatus 149
The Variables 150
The Physics 150
The Method 150
The Simulation 151
The Results 152
Further Discussion 152

26 Investigation of Mechanical Waves 153
Introduction 153
The Objective 154
The Apparatus 154
The Variables 155
The Physics 155
The Method 157
The Simulation 157
The Results 158
Further Discussion 158

27 Measuring the Speed of Water Ripples 159
Introduction 159
The Objective 159
The Apparatus 159
The Variables 160
The Physics 160
The Method 161
The Simulation 161
The Results 161
Further Discussion 162

28 Infrared Radiation 163
Introduction 163
The Objective 163
The Apparatus 163
The Variables 164
The Physics 164
The Method 165
The Simulation 165
The Results 165
Further Discussion 165

29 Diffraction Using a Monochromatic Laser 167
Introduction 167
The Objective 167
The Apparatus 167
The Variables 168
The Physics 168
The Method 170
The Simulation 170
The Results 171
Further Discussion 172

30 Inverse Square Law for Gamma Radiation 173
Introduction 173
The Objective 173
The Apparatus 174
The Variables 174
The Physics 175
The Method 175
The Simulation 175
The Results 176
Further Discussion 176

31 Refraction of Light 177
Introduction 177
The Objective 178
The Apparatus 178
The Variables 178
The Physics 178
The Method 180
The Simulation 180
The Results 181
Further Discussion 181

32 Magnetic Field Due to a Coil of Wire 183
Introduction 183
The Objective 183
The Apparatus 183
The Variables 184
The Physics 184
The Method – Current and Magnetic Field 185
The Method – Number of Turns and Magnetic Field 185
The Method – Radial Distance and Magnetic Field 186
The Simulation 186
The Results 188
Further Discussion 188

33 Investigation of Magnetic Flux of a Current-Carrying Wire 191
Introduction 191
The Objective 191
The Apparatus 191
The Variables 192
The Physics 192
The Method 194
The Simulation 195
The Results 195
Further Discussion 195

34 Magnetic Flux Linkage 197
Introduction 197
The Objective 198
The Apparatus 198
The Variables 199
The Physics 199
The Method 200
The Simulation 203
The Results 204
Further Discussion 205

Appendix 1 Uncertainties 207

Appendix 2 Using Excel for the Results 213

Appendix 3 Controlling the Simulations 221

Index 225