

Table of Contents

Preface	19
About the Author	21
Acknowledgments	22
How This Book is Organized	22
Who Should Buy This Book?	22
Conventions Used in This Book	23
How to Report Errata	24
Where to Download Material About this Book	24
Section 1 Introductory Knowledge	25
Chapter 1 How a Computer Works.....	27
1.1 Introduction	27
1.2 What is Hardware?.....	27
1.3 What is Software?	28
1.4 How a Computer Executes (Runs) a Program.....	28
1.5 Compilers and Interpreters.....	28
1.6 What is Source Code?	29
1.7 Review Questions: True/False	29
1.8 Review Questions: Multiple Choice.....	30
Chapter 2 C#	33
2.1 What is C#?	33
2.2 What is the Difference Between a Script and a Program?	33
2.3 Why You Should Learn C#	33
2.4 How C# Works	33
Chapter 3 Software Packages to Install	37
3.1 Visual Studio.....	37
3.2 How to Set Up Visual Studio Community on Windows.....	37
3.3 How to Set Up Visual Studio Code on Windows	40
3.4 How to Set Up Visual Studio Code on Linux	44
Review in "Introductory Knowledge".....	47
Review Crossword Puzzles	47
Review Questions	49
Section 2 Getting Started with C#	51
Chapter 4 Introduction to Basic Algorithmic Concepts	53
4.1 What is an Algorithm?.....	53
4.2 The Algorithm for Making a Cup of Tea	53
4.3 Properties of an Algorithm	53
4.4 Okay About Algorithms. But What is a Computer Program Anyway?	54
4.5 The Three Parties!	54
4.6 The Three Main Stages Involved in Creating an Algorithm.....	54
4.7 Flowcharts.....	55
Exercise 4.7-1 Finding the Average Value of Three Numbers.....	57

4.8	What are "Reserved Words"?	58
4.9	What is the Difference Between a Statement and a Command?	58
4.10	What is Structured Programming?	58
4.11	The Three Fundamental Control Structures.....	58
	Exercise 4.11-1 Understanding Control Structures Using Flowcharts.....	59
4.12	Your First C# Program.....	59
4.13	What is the Difference Between a Syntax Error, a Logic Error, and a Runtime Error?	60
4.14	Commenting Your Code	61
4.15	User-Friendly Programs	62
4.16	Review Questions: True/False.....	62
4.17	Review Questions: Multiple Choice.....	63
Chapter 5 Variables and Constants.....		65
5.1	What is a Variable?	65
5.2	What is a Constant?.....	66
5.3	How Many Types of Variables and Constants Exist?	69
5.4	Rules for Naming Variables and Constants in C#	69
5.5	What Does the Phrase "Declare a Variable" Mean?	69
5.6	How to Declare Variables in C#	70
5.7	How to Declare Constants in C#	71
5.8	Review Questions: True/False.....	71
5.9	Review Questions: Multiple Choice.....	72
5.10	Review Exercises.....	73
Chapter 6 Handling Input and Output		75
6.1	Which Statement Outputs Messages and Results on a User's Screen?.....	75
6.2	How to Output Special Characters	76
6.3	Which Statement Lets the User Enter Data?	77
6.4	Review Questions: True/False.....	81
6.5	Review Questions: Multiple Choice.....	81
Chapter 7 Operators.....		83
7.1	The Value Assignment Operator	83
7.2	Arithmetic Operators	85
7.3	What is the Precedence of Arithmetic Operators?	86
7.4	Compound Assignment Operators	87
	Exercise 7.4-1 Which C# Statements are Syntactically Correct?.....	88
	Exercise 7.4-2 Finding Variable Types.....	88
7.5	Incrementing/Decrementing Operators	88
7.6	String Operators	90
	Exercise 7.6-1 Concatenating Names.....	90
7.7	Review Questions: True/False.....	90
7.8	Review Questions: Multiple Choice.....	91
7.9	Review Exercises.....	93
Chapter 8 Trace Tables		95
8.1	What is a Trace Table?.....	95
	Exercise 8.1-1 Creating a Trace Table	95
	Exercise 8.1-2 Swapping Values of Variables	96

Exercise 8.1-3	Swapping Values of Variables – An Alternative Approach	98
Exercise 8.1-4	Creating a Trace Table	98
Exercise 8.1-5	Creating a Trace Table	99
8.2	Review Questions: True/False	100
8.3	Review Exercises	100
Chapter 9 Using Visual Studio Community	101	
9.1	Writing and Executing a C# Program in Visual Studio Community	101
9.2	Writing and Executing a C# Program in Visual Studio Code	106
9.3	What “Debugging” Means	110
9.4	Debugging C# Programs with Visual Studio Community	111
9.5	Debugging C# Programs with Visual Studio Code	115
9.6	Review Exercises	120
Review in “Getting Started with C#”	123	
Review Crossword Puzzles	123	
Review Questions	125	
Section 3 Sequence Control Structures.....	127	
Chapter 10 Introduction to Sequence Control Structures	129	
10.1	What is the Sequence Control Structure?	129
Exercise 10.1-1	Calculating the Area of a Rectangle	129
Exercise 10.1-2	Calculating the Area of a Circle	130
Exercise 10.1-3	Calculating Fuel Economy	131
Exercise 10.1-4	Where is the Car? Calculating Distance Traveled	131
Exercise 10.1-5	Kelvin to Fahrenheit	132
Exercise 10.1-6	Calculating Sales Tax	133
Exercise 10.1-7	Calculating a Sales Discount	133
Exercise 10.1-8	Calculating the Sales Tax Rate and Discount	134
10.2	Review Exercises	135
Chapter 11 Manipulating Numbers	137	
11.1	Introduction	137
11.2	Useful Mathematical Methods (Subprograms), and More	137
Exercise 11.2-1	Calculating the Distance Between Two Points	142
Exercise 11.2-2	How Far Did the Car Travel?	143
11.3	Review Questions: True/False	144
11.4	Review Questions: Multiple Choice	145
11.5	Review Exercises	145
Chapter 12 Complex Mathematical Expressions	147	
12.1	Writing Complex Mathematical Expressions	147
Exercise 12.1-1	Representing Mathematical Expressions in C#	147
Exercise 12.1-2	Writing a Mathematical Expression in C#	148
Exercise 12.1-3	Writing a Complex Mathematical Expression in C#	148
12.2	Review Exercises	150
Chapter 13 Exercises With a Quotient and a Remainder.....	153	
13.1	Introduction	153
Exercise 13.1-1	Calculating the Quotient and Remainder of Integer Division	153
Exercise 13.1-2	Finding the Sum of Digits	154

Exercise 13.1-3 Displaying an Elapsed Time	158
Exercise 13.1-4 Reversing a Number	160
13.2 Review Exercises.....	160
Chapter 14 Manipulating Strings	163
14.1 Introduction	163
14.2 The Position of a Character in a String.....	163
14.3 Useful String Methods (Subprograms), and More.....	163
Exercise 14.3-1 Displaying a String Backwards	169
Exercise 14.3-2 Switching the Order of Names	169
Exercise 14.3-3 Creating a Login ID	170
Exercise 14.3-4 Creating a Random Word	171
Exercise 14.3-5 Finding the Sum of Digits.....	172
14.4 Review Questions: True/False.....	173
14.5 Review Questions: Multiple Choice.....	173
14.6 Review Exercises.....	175
Review in "Sequence Control Structures".....	177
Review Crossword Puzzle.....	177
Review Questions	177
Section 4 Decision Control Structures.....	179
Chapter 15 Making Questions.....	181
15.1 Introduction	181
15.2 What is a Boolean Expression?	181
15.3 How to Write Simple Boolean Expressions.....	181
Exercise 15.3-1 Filling in the Table	182
15.4 Logical Operators and Complex Boolean Expressions	182
15.5 Assigning the Result of a Boolean Expression to a Variable	184
15.6 What is the Order of Precedence of Logical Operators?	184
15.7 What is the Order of Precedence of Arithmetic, Comparison, and Logical Operators?	185
Exercise 15.7-1 Filling in the Truth Table	185
Exercise 15.7-2 Calculating the Results of Complex Boolean Expressions	187
Exercise 15.7-3 Converting English Sentences to Boolean Expressions	187
15.8 How to Negate Boolean Expressions.....	189
Exercise 15.8-1 Negating Boolean Expressions.....	190
15.9 Review Questions: True/False.....	191
15.10 Review Questions: Multiple Choice.....	192
15.11 Review Exercises.....	193
Chapter 16 The Single-Alternative Decision Structure.....	195
16.1 The Single-Alternative Decision Structure	195
Exercise 16.1-1 Trace Tables and Single-Alternative Decision Structures	197
Exercise 16.1-2 The Absolute Value of a Number	198
16.2 Review Questions: True/False.....	199
16.3 Review Questions: Multiple Choice.....	200
16.4 Review Exercises.....	201
Chapter 17 The Dual-Alternative Decision Structure.....	203
17.1 The Dual-Alternative Decision Structure	203

Exercise 17.1-1	Finding the Output Message.....	204
Exercise 17.1-2	Trace Tables and Dual-Alternative Decision Structures.....	204
Exercise 17.1-3	Who is the Greatest?	205
Exercise 17.1-4	Finding Odd and Even Numbers	207
Exercise 17.1-5	Weekly Wages	208
17.2	Review Questions: True/False	209
17.3	Review Questions: Multiple Choice.....	210
17.4	Review Exercises.....	211
Chapter 18 The Multiple-Alternative Decision Structure		215
18.1	The Multiple-Alternative Decision Structure	215
Exercise 18.1-1	Trace Tables and Multiple-Alternative Decision Structures	216
Exercise 18.1-2	Counting the Digits	218
18.2	Review Questions: True/False	220
18.3	Review Exercises.....	221
Chapter 19 The Case Decision Structure		225
19.1	The Case Decision Structure	225
Exercise 19.1-1	The Days of the Week	226
19.2	Review Questions: True/False	228
19.3	Review Exercises.....	229
Chapter 20 Nested Decision Control Structures.....		233
20.1	What are Nested Decision Control Structures?	233
Exercise 20.1-1	Trace Tables and Nested Decision Control Structures	234
Exercise 20.1-2	Positive, Negative or Zero?	236
20.2	A Mistake That You Will Probably Make!	237
20.3	Review Questions: True/False	240
20.4	Review Exercises.....	240
Chapter 21 More about Flowcharts with Decision Control Structures		245
21.1	Introduction	245
21.2	Converting C# Programs to Flowcharts.....	245
Exercise 21.2-1	Designing the Flowchart	246
Exercise 21.2-2	Designing the Flowchart	247
Exercise 21.2-3	Designing the Flowchart	249
21.3	Converting Flowcharts to C# Programs.....	250
Exercise 21.3-1	Writing the C# Program	251
Exercise 21.3-2	Writing the C# Program	252
Exercise 21.3-3	Writing the C# Program	253
21.4	Review Exercises.....	256
Chapter 22 Tips and Tricks with Decision Control Structures		263
22.1	Introduction	263
22.2	Choosing a Decision Control Structure.....	263
22.3	Streamlining the Decision Control Structure.....	264
Exercise 22.3-1	“Shrinking” the Algorithm	265
Exercise 22.3-2	“Shrinking” the C# Program	265
Exercise 22.3-3	“Shrinking” the Algorithm	266
22.4	Logical Operators – to Use, or not to Use: That is the Question!.....	268
Exercise 22.4-1	Rewriting the Code	270

Exercise 22.4-2	Rewriting the Code	271
22.5	Merging Two or More Single-Alternative Decision Structures	271
Exercise 22.5-1	Merging the Decision Control Structures	272
Exercise 22.5-2	Merging the Decision Control Structures	273
22.6	Replacing Two Single-Alternative Decision Structures with a Dual-Alternative One.....	274
Exercise 22.6-1	"Merging" the Decision Control Structures.....	275
22.7	Put the Boolean Expressions Most Likely to be True First.....	276
Exercise 22.7-1	Rearranging the Boolean Expressions	277
22.8	Why is Code Indentation so Important?	278
22.9	Review Questions: True/False.....	279
22.10	Review Questions: Multiple Choice.....	279
22.11	Review Exercises.....	281
Chapter 23 More Exercises with Decision Control Structures	287	
23.1	Simple Exercises with Decision Control Structures	287
Exercise 23.1-1	Both Odds or Both Evens?.....	287
Exercise 23.1-2	Is it an Integer?.....	287
Exercise 23.1-3	Validating Data Input and Finding Odd and Even Numbers.....	288
Exercise 23.1-4	Converting Gallons to Liters, and Vice Versa	289
Exercise 23.1-5	Converting Gallons to Liters, and Vice Versa (with Data Validation)	290
Exercise 23.1-6	Where is the Tollkeeper?.....	292
Exercise 23.1-7	The Most Scientific Calculator Ever!	293
23.2	Decision Control Structures in Solving Mathematical Problems.....	294
Exercise 23.2-1	Finding the Value of y.....	294
Exercise 23.2-2	Finding the Values of y.....	295
Exercise 23.2-3	Solving the Linear Equation $ax + b = 0$	296
Exercise 23.2-4	Solving the Quadratic Equation $ax^2 + bx + c = 0$	297
23.3	Finding Minimum and Maximum Values with Decision Control Structures	300
Exercise 23.3-1	Finding the Name of the Heaviest Person	301
23.4	Exercises with Series of Consecutive Ranges of Values.....	302
Exercise 23.4-1	Calculating the Discount	303
Exercise 23.4-2	Validating Data Input and Calculating the Discount.....	305
Exercise 23.4-3	Sending a Parcel.....	306
Exercise 23.4-4	Finding the Values of y.....	309
Exercise 23.4-5	Progressive Rates and Electricity Consumption	312
Exercise 23.4-6	Progressive Rates and Text Messaging Services	313
23.5	Exercises of a General Nature with Decision Control Structures	314
Exercise 23.5-1	Finding a Leap Year	314
Exercise 23.5-2	Displaying the Days of the Month.....	315
Exercise 23.5-3	Is the Number a Palindrome?.....	317
Exercise 23.5-4	Checking for Proper Capitalization and Punctuation	319
23.6	Review Exercises.....	320
Review in "Decision Control Structures"	325	
Review Crossword Puzzle	325	
Review Questions	325	
Section 5 Loop Control Structures	327	
Chapter 24 Introduction to Loop Control Structures.....	329	
24.1	What is a Loop Control Structure?	329

24.2	From Sequence Control to Loop Control Structures	329
24.3	Review Questions: True/False	331
Chapter 25 Pre-Test, Mid-Test and Post-Test Loop Structures	333	
25.1	The Pre-Test Loop Structure.....	333
Exercise 25.1-1	Designing the Flowchart and Counting the Total Number of Iterations.....	334
Exercise 25.1-2	Counting the Total Number of Iterations.....	335
Exercise 25.1-3	Designing the Flowchart and Counting the Total Number of Iterations.....	335
Exercise 25.1-4	Counting the Total Number of Iterations.....	336
Exercise 25.1-5	Finding the Sum of Four Numbers	336
Exercise 25.1-6	Finding the Sum of Odd Numbers.....	337
Exercise 25.1-7	Finding the Sum of N Numbers.....	338
Exercise 25.1-8	Finding the Sum of an Unknown Quantity of Numbers	339
Exercise 25.1-9	Finding the Product of 20 Numbers	340
25.2	The Post-Test Loop Structure.....	341
Exercise 25.2-1	Designing the Flowchart and Counting the Total Number of Iterations.....	342
Exercise 25.2-2	Counting the Total Number of Iterations.....	343
Exercise 25.2-3	Designing the Flowchart and Counting the Total Number of Iterations.....	344
Exercise 25.2-4	Counting the Total Number of Iterations.....	345
Exercise 25.2-5	Finding the Product of N Numbers	345
25.3	The Mid-Test Loop Structure.....	346
Exercise 25.3-1	Designing the Flowchart and Counting the Total Number of Iterations.....	347
25.4	Review Questions: True/False	349
25.5	Review Questions: Multiple Choice.....	350
25.6	Review Exercises.....	353
Chapter 26 The <code>for</code> statement	359	
26.1	The <code>for</code> statement.....	359
Exercise 26.1-1	Creating the Trace Table	361
Exercise 26.1-2	Creating the Trace Table	363
Exercise 26.1-3	Counting the Total Number of Iterations	364
Exercise 26.1-4	Finding the Sum of Four Numbers	365
Exercise 26.1-5	Finding the Square Roots from 0 to N	365
Exercise 26.1-6	Finding the Sum of $1 + 2 + 3 + \dots + 100$	366
Exercise 26.1-7	Finding the Product of $2 \times 4 \times 6 \times 8 \times 10$	367
Exercise 26.1-8	Finding the Sum of $2^2 + 4^2 + 6^2 + \dots + (2N)^2$	368
Exercise 26.1-9	Finding the Sum of $3^3 + 6^6 + 9^9 + \dots + (3N)^{3N}$	368
Exercise 26.1-10	Finding the Average Value of Positive Numbers	369
Exercise 26.1-11	Counting the Vowels	370
26.2	Rules that Apply to For-Loops.....	370
Exercise 26.2-1	Counting the Total Number of Iterations	371
Exercise 26.2-2	Counting the Total Number of Iterations	371
Exercise 26.2-3	Counting the Total Number of Iterations	372
Exercise 26.2-4	Counting the Total Number of Iterations	373
Exercise 26.2-5	Finding the Sum of N Numbers	373
26.3	Review Questions: True/False	374
26.4	Review Questions: Multiple Choice.....	375
26.5	Review Exercises.....	377
Chapter 27 Nested Loop Control Structures.....	381	

27.1	What is a Nested Loop?	381
	Exercise 27.1-1 Say "Hello Zeus". Counting the Total Number of Iterations.....	382
	Exercise 27.1-2 Creating the Trace Table.....	382
27.2	Rules that Apply to Nested Loops.....	384
	Exercise 27.2-1 Breaking the First Rule.....	384
	Exercise 27.2-2 Counting the Total Number of Iterations.....	384
27.3	Review Questions: True/False.....	385
27.4	Review Questions: Multiple Choice.....	386
27.5	Review Exercises.....	388
Chapter 28	Tips and Tricks with Loop Control Structures	391
28.1	Introduction	391
28.2	Choosing a Loop Control Structure.....	391
28.3	The "Ultimate" Rule.....	391
28.4	Breaking Out of a Loop	395
28.5	Cleaning Out Your Loops	397
	Exercise 28.5-1 Cleaning Out the Loop.....	397
	Exercise 28.5-2 Cleaning Out the Loop.....	398
28.6	Endless Loops and How to Avoid Them	399
28.7	The "From Inner to Outer" Method.....	400
28.8	Review Questions: True/False.....	401
28.9	Review Questions: Multiple Choice.....	402
28.10	Review Exercises.....	403
Chapter 29	Flowcharts with Loop Control Structures.....	407
29.1	Introduction	407
29.2	Converting C# Programs to Flowcharts	407
	Exercise 29.2-1 Designing the Flowchart Fragment	408
	Exercise 29.2-2 Designing the Flowchart Fragment	408
	Exercise 29.2-3 Designing the Flowchart	409
	Exercise 29.2-4 Designing the Flowchart Fragment	411
	Exercise 29.2-5 Designing the Flowchart	412
	Exercise 29.2-6 Designing the Flowchart.....	413
29.3	Converting Flowcharts to C# Programs	414
	Exercise 29.3-1 Writing the C# Program.....	414
	Exercise 29.3-2 Writing the C# Program.....	415
	Exercise 29.3-3 Writing the C# Program.....	416
	Exercise 29.3-4 Writing the C# Program.....	418
29.4	Review Exercises.....	420
Chapter 30	More Exercises with Loop Control Structures	427
30.1	Simple Exercises with Loop Control Structures	427
	Exercise 30.1-1 Counting the Numbers According to Which is Greater	427
	Exercise 30.1-2 Counting the Numbers According to Their Digits	428
	Exercise 30.1-3 How Many Numbers Fit in a Sum	428
	Exercise 30.1-4 Finding the Total Number of Positive Integers.....	429
	Exercise 30.1-5 Iterating as Many Times as the User Wishes	430
	Exercise 30.1-6 Finding the Sum of the Digits.....	431
30.2	Exercises with Nested Loop Control Structures	433
	Exercise 30.2-1 Displaying all Three-Digit Integers that Contain a Given Digit	433

Exercise 30.2-2 Displaying all Instances of a Specified Condition.....	435
30.3 Data Validation with Loop Control Structures.....	436
Exercise 30.3-1 Finding Odd and Even Numbers - Validation Without Error Messages.....	438
Exercise 30.3-2 Finding Odd and Even Numbers - Validation with One Error Message	439
Exercise 30.3-3 Finding Odd and Even Numbers - Validation with Individual Error Messages.....	439
Exercise 30.3-4 Finding the Sum of Four Numbers	440
30.4 Using Loop Control Structures to Solve Mathematical Problems	441
Exercise 30.4-1 Calculating the Area of as Many Triangles as the User Wishes	441
Exercise 30.4-2 Finding x and y.....	442
Exercise 30.4-3 The Russian Multiplication Algorithm	443
Exercise 30.4-4 Finding the Number of Divisors	445
Exercise 30.4-5 Is the Number a Prime?	446
Exercise 30.4-6 Finding all Prime Numbers from 1 to N.....	447
Exercise 30.4-7 Heron's Square Root	448
Exercise 30.4-8 Calculating π.....	450
Exercise 30.4-9 Approximating a Real with a Fraction.....	451
30.5 Finding Minimum and Maximum Values with Loop Control Structures.....	452
Exercise 30.5-1 Validating and Finding the Minimum and the Maximum Value.....	454
Exercise 30.5-2 Validating and Finding the Hottest Planet.....	455
Exercise 30.5-3 "Making the Grade"	457
30.6 Exercises of a General Nature with Loop Control Structures.....	458
Exercise 30.6-1 Fahrenheit to Kelvin, from 0 to 100	458
Exercise 30.6-2 Rice on a Chessboard.....	459
Exercise 30.6-3 Just a Poll	460
Exercise 30.6-4 Is the Message a Palindrome?.....	461
30.7 Review Questions: True/False	463
30.8 Review Exercises.....	464
<i>Review in "Loop Control Structures"</i>	471
Review Crossword Puzzle.....	471
Review Questions	471
Section 6 Data Structures in C#	473
<i>Chapter 31 One-Dimensional Arrays and Dictionaries</i>.....	475
31.1 Introduction	475
31.2 What is an Array?.....	476
Exercise 31.2-1 Designing an Array	477
Exercise 31.2-2 Designing Arrays.....	478
Exercise 31.2-3 Designing Arrays.....	478
31.3 Creating One-Dimensional Arrays in C#	479
31.4 How to Get Values from a One-Dimensional Array.....	480
Exercise 31.4-1 Creating the Trace Table	481
Exercise 31.4-2 Using a Non-Existing Index.....	481
31.5 How to Alter the Value of an Array Element.....	482
31.6 How to Iterate Through a One-Dimensional Array.....	482
Exercise 31.6-1 Finding the Sum.....	483
31.7 How to Add User-Entered Values to a One-Dimensional Array	484
Exercise 31.7-1 Displaying Words in Reverse Order	485
Exercise 31.7-2 Displaying Positive Numbers in Reverse Order	485

Exercise 31.7-3	Finding the Average Value	486
Exercise 31.7-4	Displaying Reals Only.....	487
Exercise 31.7-5	Displaying Elements with Odd-Numbered Indexes.....	488
Exercise 31.7-6	Displaying Even Numbers in Odd-Numbered Index Positions.....	489
31.8	What is a Dictionary?	489
31.9	Creating Dictionaries in C#.....	489
31.10	How to Get a Value from a Dictionary	491
	Exercise 31.10-1 Using a Non-Existing Key in Dictionaries	491
31.11	How to Alter the Value of a Dictionary Element	491
	Exercise 31.11-1 Assigning a Value to a Non-Existing Key.....	492
31.12	How to Iterate Through a Dictionary.....	492
31.13	Review Questions: True/False	493
31.14	Review Questions: Multiple Choice.....	496
31.15	Review Exercises.....	499
Chapter 32 Two-Dimensional Arrays	503	
32.1	Creating Two-Dimensional Arrays in C#.....	503
32.2	How to Get Values from Two-Dimensional Arrays	504
	Exercise 32.2-1 Creating the Trace Table.....	505
32.3	How to Iterate Through a Two-Dimensional Array.....	506
32.4	How to Add User-Entered Values to a Two-Dimensional Array	509
	Exercise 32.4-1 Displaying Reals Only.....	510
	Exercise 32.4-2 Displaying Odd Columns Only.....	510
32.5	What's the Story on Variables i and j?.....	511
32.6	Square Matrices	511
	Exercise 32.6-1 Finding the Sum of the Elements of the Main Diagonal	512
	Exercise 32.6-2 Finding the Sum of the Elements of the Antidiagonal	513
	Exercise 32.6-3 Filling in the Array	514
32.7	Review Questions: True/False.....	516
32.8	Review Questions: Multiple Choice.....	518
32.9	Review Exercises.....	520
Chapter 33 Tips and Tricks with Arrays	525	
33.1	Introduction	525
33.2	Processing Each Row Individually	525
	Exercise 33.2-1 Finding the Average Value	526
33.3	Processing Each Column Individually	528
	Exercise 33.3-1 Finding the Average Value	530
33.4	How to Use More Than One Data Structures in a Program	532
	Exercise 33.4-1 Finding the Average Value of Two Grades	532
	Exercise 33.4-2 Finding the Average Value of More than Two Grades	533
	Exercise 33.4-3 Using an Array Along with a Dictionary	536
33.5	Creating a One-Dimensional Array from a Two-Dimensional Array	537
33.6	Creating a Two-Dimensional Array from a One-Dimensional Array	538
33.7	Review Questions: True/False	539
33.8	Review Questions: Multiple Choice.....	540
33.9	Review Exercises.....	542
Chapter 34 More Exercises with Arrays.....	545	

34.1 Simple Exercises with Arrays	545
Exercise 34.1-1 Creating an Array that Contains the Average Values of its Neighboring Elements	545
Exercise 34.1-2 Creating an Array with the Greatest Values	546
Exercise 34.1-3 Merging One-Dimensional Arrays	546
Exercise 34.1-4 Merging Two-Dimensional Arrays	548
Exercise 34.1-5 Creating Two Arrays – Separating Positive from Negative Values.....	548
Exercise 34.1-6 Creating an Array with Those who Contain Digit 5	551
34.2 Data Validation with Arrays	552
Exercise 34.2-1 Displaying Odds in Reverse Order – Validation Without Error Messages.....	553
Exercise 34.2-2 Displaying Odds in Reverse Order – Validation with One Error Message	554
Exercise 34.2-3 Displaying Odds in Reverse Order – Validation with Individual Error Messages.....	554
34.3 Finding Minimum and Maximum Values in Arrays	555
Exercise 34.3-1 Which Depth is the Greatest?.....	555
Exercise 34.3-2 Which Lake is the Deepest?	556
Exercise 34.3-3 Which Lake, in Which Country, Having Which Average Area, is the Deepest?	557
Exercise 34.3-4 Which Students Have got the Greatest Grade?.....	559
Exercise 34.3-5 Finding the Minimum Value of a Two-Dimensional Array.....	560
Exercise 34.3-6 Finding the City with the Coldest Day	562
Exercise 34.3-7 Finding the Minimum and the Maximum Value of Each Row.....	563
34.4 Sorting Arrays.....	566
Exercise 34.4-1 The Bubble Sort Algorithm – Sorting One-Dimensional Arrays with Numeric Values.....	566
Exercise 34.4-2 Sorting One-Dimensional Arrays with Alphanumeric Values.....	571
Exercise 34.4-3 Sorting One-Dimensional Arrays While Preserving the Relationship with a Second Array ...	572
Exercise 34.4-4 Sorting Last and First Names.....	573
Exercise 34.4-5 Sorting a Two-Dimensional Array.....	576
Exercise 34.4-6 The Modified Bubble Sort Algorithm – Sorting One-Dimensional Arrays	577
Exercise 34.4-7 The Five Best Scorers	578
Exercise 34.4-8 The Selection Sort Algorithm – Sorting One-Dimensional Arrays.....	581
Exercise 34.4-9 Sorting One-Dimensional Arrays While Preserving the Relationship with a Second Array ...	583
Exercise 34.4-10 The Insertion Sort Algorithm – Sorting One-Dimensional Arrays.....	584
Exercise 34.4-11 The Three Worst Elapsed Times.....	586
34.5 Searching Elements in Data Structures.....	588
Exercise 34.5-1 The Linear Search Algorithm – Searching in a One-Dimensional Array that may Contain the Same Value Multiple Times.....	588
Exercise 34.5-2 Display the Last Names of All Those People Who Have the Same First Name	589
Exercise 34.5-3 The Linear Search Algorithm – Searching in a One-Dimensional Array that Contains Unique Values	590
Exercise 34.5-4 Searching for a Given Social Security Number	591
Exercise 34.5-5 The Linear Search Algorithm – Searching in a Two-Dimensional Array that May Contain the Same Value Multiple Times.....	592
Exercise 34.5-6 Searching for Wins, Losses and Ties	593
Exercise 34.5-7 The Linear Search Algorithm – Searching in a Two-Dimensional Array that Contains Unique Values	595
Exercise 34.5-8 Checking if a Value Exists in all Columns	596
Exercise 34.5-9 The Binary Search Algorithm – Searching in a Sorted One-Dimensional Array	599
Exercise 34.5-10 Display all the Historical Events for a Country	601
Exercise 34.5-11 Searching in Each Column of a Two-Dimensional Array.....	602
34.6 Exercises of a General Nature with Arrays.....	605
Exercise 34.6-1 On Which Days was There a Possibility of Snow?	605

Exercise 34.6-2 Was There Any Possibility of Snow?.....	606
Exercise 34.6-3 In Which Cities was There a Possibility of Snow?.....	608
Exercise 34.6-4 Display from Highest to Lowest Grades by Student, and in Alphabetical Order	611
Exercise 34.6-5 Archery at the Summer Olympics.....	612
34.7 Review Questions: True/False.....	614
34.8 Review Exercises.....	616
Review in "Data Structures in C#"	625
Review Crossword Puzzle.....	625
Review Questions	625
Section 7 Subprograms	627
Chapter 35 Introduction to Subprograms	629
35.1 What Exactly is a Subprogram?	629
35.2 What is Procedural Programming?.....	629
35.3 What is Modular Programming?	630
35.4 Review Questions: True/False.....	631
Chapter 36 User-Defined Subprograms.....	633
36.1 Subprograms that Return Values.....	633
36.2 How to Make a Call to a Method	634
36.3 Subprograms that Return no Values	636
36.4 How to Make a Call to a void Method.....	637
36.5 Formal and Actual Arguments	638
36.6 How Does a Method Execute?	638
Exercise 36.6-1 Back to Basics – Calculating the Sum of Two Numbers	640
Exercise 36.6-2 Calculating the Sum of Two Numbers Using Fewer Lines of Code!	641
36.7 How Does a void Method Execute?	641
Exercise 36.7-1 Back to Basics – Displaying the Absolute Value of a Number	643
36.8 Review Questions: True/False.....	644
36.9 Review Exercises.....	646
Chapter 37 Tips and Tricks with Subprograms	651
37.1 Can Two Subprograms use Variables of the Same Name?.....	651
37.2 Can a Subprogram Call Another Subprogram?.....	652
37.3 Passing Arguments by Value and by Reference	653
Exercise 37.3-1 Finding the Logic Error	655
37.4 Passing and/or Returning an Array.....	656
37.5 Default Argument Values (Optional Arguments) and Named Arguments	659
37.6 Overloading Methods.....	660
37.7 The Scope of a Variable	662
37.8 Converting Parts of Code into Subprograms	664
37.9 Recursion.....	668
Exercise 37.9-1 Calculating the Fibonacci Sequence Recursively	670
37.10 Review Questions: True/False.....	672
37.11 Review Exercises.....	673
Chapter 38 More Exercises with Subprograms	681
38.1 Simple Exercises with Subprograms.....	681
Exercise 38.1-1 Designing the Flowchart.....	681

Exercise 38.1-2 Designing the Flowchart	682
Exercise 38.1-3 A Simple Currency Converter.....	683
Exercise 38.1-4 A More Complete Currency Converter.....	684
Exercise 38.1-5 Finding the Average Values of Positive Integers.....	686
Exercise 38.1-6 Finding the Sum of Odd Positive Integers	687
Exercise 38.1-7 Finding the Values of y.....	688
38.2 Exercises of a General Nature with Subprograms	689
Exercise 38.2-1 Validating Data Input Using a Subprogram	689
Exercise 38.2-2 Sorting an Array Using a Subprogram.....	690
Exercise 38.2-3 Progressive Rates and Electricity Consumption	692
Exercise 38.2-4 Roll, Roll, Roll the... Dice!.....	693
Exercise 38.2-5 How Many Times Does Each Number of the Dice Appear?.....	694
38.3 Review Exercises.....	696
<i>Review in "Subprograms"</i>	705
Review Crossword Puzzle.....	705
Review Questions	706
Section 8 Object-Oriented Programming	707
<i>Chapter 39 Introduction to Object-Oriented Programming</i>.....	709
39.1 What is Object-Oriented Programming?	709
39.2 Classes and Objects in C#	710
39.3 The Constructor and the Keyword this	712
39.4 Passing Initial Values to the Constructor	713
Exercise 39.4-1 Historical Events.....	714
39.5 Getter and Setter Methods vs Properties	715
Exercise 39.5-1 The Roman Numerals	719
39.6 Can a Method Call Another Method of the Same Class?.....	722
Exercise 39.6-1 Doing Math.....	723
39.7 Class Inheritance	724
39.8 Review Questions: True/False	728
39.9 Review Exercises.....	728
<i>Review in "Object-Oriented Programming"</i>	733
Review Crossword Puzzle.....	733
Review Questions	733
Some Final Words from the Author.....	735
Index.....	736
Some of my Books	743