

IT Essentials

PC Hardware and Software Companion Guide

Fifth Edition



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IT Essentials:

PC Hardware and Software Companion Guide

Fifth Edition

Cisco Networking Academy

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Contents At a Glance

	Introduction	xxiv
Chapter 1	Introduction to the Personal Computer	1
Chapter 2	Lab Procedures and Tool Use	75
Chapter 3	Computer Assembly	105
Chapter 4	Overview of Preventive Maintenance	155
Chapter 5	Operating Systems	179
Chapter 6	Networks	295
Chapter 7	Laptops	393
Chapter 8	Mobile Devices	451
Chapter 9	Printers	503
Chapter 10	Security	541
Chapter 11	The IT Professional	607
Chapter 12	Advanced Troubleshooting	633
Appendix A	Answers to “Check Your Understanding” Questions	683
	Glossary	699
	Index	737

Contents

Introduction xxiv

Chapter 1 Introduction to the Personal Computer 1

Objectives 1

Key Terms 1

Introduction (1.0.1) 4

Cases and Power Supplies (1.1.1) 4

Computer Cases (1.1.1.1) 4

Power Supplies (1.1.1.2) 6

Connectors 7

Electricity and Ohm's Law (1.1.1.3) 8

Internal PC Components (1.1.2) 11

Motherboards (1.1.2.1) 11

CPUs (1.1.2.2) 13

Cooling Systems (1.1.2.3) 16

ROM and RAM 18

ROM (1.1.2.4) 18

RAM (1.1.2.5) 19

Memory Modules (1.1.2.6) 20

Cache Memory 22

Error Checking 22

Adapter Cards and Expansion Slots (1.1.2.7) 22

Storage Devices and RAID (1.1.2.8) 25

Floppy Drive 26

Hard Drive 26

Tape Drive 27

Optical Drive 27

External Flash Drive 28

Types of Drive Interfaces 28

Internal Cables (1.1.2.9) 30

External Ports and Cables (1.1.3) 31

Video Ports and Cables (1.1.3.1) 31

Other Ports and Cables (1.1.3.2) 35

Serial Ports and Cables 35

Modem Ports and Cables 36

USB Ports and Cables 36

FireWire Ports and Cables 37

<i>Parallel Ports and Cables</i>	38
<i>eSATA Data Cables</i>	38
<i>SCSI Ports and Cables</i>	38
<i>Network Ports and Cables</i>	39
<i>PS/2 Ports</i>	40
<i>Audio Ports</i>	40

Input and Output Devices (1.1.4) 41

Input Devices (1.1.4.1)	41
<i>Mice and Keyboards</i>	41
<i>Gamepads and Joysticks</i>	42
<i>Digital Cameras and Digital Video Cameras</i>	42
<i>Biometric Identification Devices</i>	43
<i>Touchscreens</i>	43
<i>Digitizers</i>	43
<i>Scanners</i>	44
Output Devices (1.1.4.2)	44
<i>Monitors and Projectors</i>	44
<i>All-in-One Printers</i>	46
<i>Speakers and Headphones</i>	46
Monitor Characteristics (1.1.4.3)	46
<i>Connecting Multiple Monitors to a Single Computer</i>	48

Selecting PC Components (1.2.1) 49

Case and Power Supply (1.2.1.1)	49
Selecting Motherboards (1.2.1.2)	50
Selecting the CPU and Heat Sink and Fan Assembly (1.2.1.3)	51
Selecting RAM (1.2.1.4)	53
Selecting Adapter Cards (1.2.1.5)	54
<i>Graphics Cards</i>	54
<i>Sound Cards</i>	55
<i>Storage Controllers</i>	55
<i>I/O Cards</i>	56
<i>NICs</i>	56
<i>Capture Cards</i>	57
Selecting Hard Drives and Floppy Drives (1.2.1.6)	57
<i>Floppy Disk Drive</i>	57
<i>Hard Drives</i>	57
Selecting Solid State Drives and Media Readers (1.2.1.7)	60
<i>Solid State Drives</i>	60
<i>Media Readers</i>	61
Selecting Optical Drives (1.2.1.8)	62
Selecting External Storage (1.2.1.9)	62
Selecting Input and Output Devices (1.2.1.10)	63

Specialized Computer Systems (1.3.1) 64

CAX Workstations (1.3.1.1) 65

Audio and Video Editing Workstations (1.3.1.2) 65

Virtualization Workstations (1.3.1.3) 67

Gaming PCs (1.3.1.4) 68

Home Theater PCs (1.3.1.5) 69

Summary (1.4.1) 71

Summary of Exercises 71

Worksheets 71

Check Your Understanding 72

Chapter 2 Lab Procedures and Tool Use 75

Objectives 75

Key Terms 75

Introduction (2.0.1) 77

Safe Lab Procedures (2.1) 77

General Safety (2.1.1.1) 77

Electrical Safety (2.1.1.2) 78

Fire Safety (2.1.1.3) 78

Procedures to Protect Equipment and Data (2.1.2) 79

ESD and EMI (2.1.2.1) 79

Climate 80

Power Fluctuation Types (2.1.2.2) 80

Power Protection Devices (2.1.2.3) 81

Procedures to Protect the Environment (2.1.3) 82

Material Safety and Data Sheet (2.1.3.1) 82

Equipment Disposal (2.1.3.2) 83

Batteries 83

Monitors 84

Toner Kits, Cartridges, and Developers 84

Chemical Solvents and Aerosol Cans 84

Proper Use of Tools (2.2) 84

Hardware Tools (2.2.1) 84

ESD Tools (2.2.1.2) 85

Hand Tools (2.2.1.3) 85

Cleaning Tools (2.2.1.4) 86

Diagnostic Tools (2.2.1.5) 86

Software Tools (2.2.2)	88
<i>Disk Management Tools (2.2.2.1)</i>	88
<i>Protection Software Tools (2.2.2.2)</i>	89
Organizational Tools (2.2.3)	89
<i>Reference Tools (2.2.3.1)</i>	89
<i>Miscellaneous Tools (2.2.3.2)</i>	91
Demonstrate Proper Tool Use (2.2.4)	92
<i>Antistatic Wrist Strap (2.2.4.1)</i>	92
<i>Antistatic Mat (2.2.4.2)</i>	93
<i>Hand Tools (2.2.4.3)</i>	94
<i>Cleaning Materials (2.2.4.6)</i>	98

Summary (2.3.1) 101

Summary of Exercises 101

Labs	101
Worksheets	102

Check Your Understanding 102

Chapter 3

Computer Assembly 105

Objectives 105

Key Terms 105

Introduction (3.0.1) 106

Open the Case and Install the Power Supply (3.1.1) 106

Open the Case (3.1.1.1)	106
Install the Power Supply (3.1.1.2)	107

Install the Motherboard (3.1.2) 108

Install the CPU, Heat Sink, and Fan Assembly (3.1.2.1)	108
<i>CPU</i>	108
<i>Heat Sink and Fan Assembly</i>	110
Install RAM (3.1.2.2)	111
Install the Motherboard (3.1.2.3)	112

Install the Drives (3.1.3) 113

Install the Internal Drive (3.1.3.1)	113
Install the Optical Drive (3.1.3.2)	113
Install the Floppy Drive (3.1.3.3)	114

Install the Adapter Cards (3.1.4) 115

Types of Adapter Cards (3.1.4.1)	115
Install a NIC (3.1.4.2)	116
Install a Wireless NIC (3.1.4.3)	116
Install a Video Adapter Card (3.1.4.4)	117

Install the Cables (3.1.5) 118

Install the Internal Power Cables (3.1.5.1) 118

Motherboard Power Connections 118

SATA Power Connectors 119

Molex Power Connectors 119

Berg Power Connectors 119

Install the Internal Data Cables (3.1.5.2) 120

PATA Data Cables 120

SATA Data Cables 121

Floppy Data Cables 121

Install the Front Panel Cables (3.1.5.4) 122

Power and Reset Buttons 123

Power and Drive Activity LEDs 124

System Speaker 124

USB 124

Audio 125

Install the Case Assembly (3.1.5.6) 126

Install the External Cables (3.1.5.7) 126

POST and BIOS (3.2.1) 128

BIOS Beep Codes and Setup (3.2.1.1) 128

POST Card 129

BIOS Setup (3.2.1.2) 129

BIOS Configuration (3.2.2) 131

BIOS Component Information (3.2.2.1) 131

BIOS Configurations (3.2.2.2) 131

Time and Date 131

Disabling Devices 132

Boot Order 132

Clock Speed 132

Virtualization 133

BIOS Security Configurations (3.2.2.3) 133

BIOS Hardware Diagnostics and Monitoring (3.2.2.4) 134

Temperatures 134

Fan Speeds 135

Voltages 135

Clock and Bus Speeds 135

Intrusion Detection 136

Built-In Diagnostics 136

Motherboard and Related Components (3.3.1) 137

Motherboard Component Upgrades (3.3.1.1) 137

CPU Installation 138

Jumper Settings 138

CMOS Battery Installation 139

	Upgrade the Motherboard (3.3.1.2)	139
	<i>BIOS Updates</i>	140
	Upgrade CPU and Heat Sink and Fan Assembly (3.3.1.3)	141
	Upgrade the RAM (3.3.1.4)	142
	Upgrade the BIOS (3.3.1.5)	143
	Storage Devices (3.3.2)	144
	Upgrade Hard Drives and RAID (3.3.2.1)	144
	Input and Output Devices (3.3.3)	147
	Upgrade Input and Output Devices (3.3.3.1)	147
	Summary (3.4.1.1)	149
	Summary of Exercises	149
	Virtual Desktop Activities	150
	Labs	150
	Worksheets	150
	Check Your Understanding	151
Chapter 4	Overview of Preventive Maintenance	155
	Objectives	155
	Key Terms	155
	Introduction (4.0.1)	156
	Preventive Maintenance (4.1)	156
	Benefits of Preventive Maintenance (4.1.1.1)	156
	Preventive Maintenance Tasks (4.1.1.2)	157
	<i>Hardware</i>	157
	<i>Software</i>	157
	Clean the Case and Internal Components (4.1.1.3)	158
	Inspect Internal Components (4.1.1.4)	159
	Environmental Concerns (4.1.1.5)	160
	Troubleshooting Process Steps (4.2.1)	160
	Introduction to Troubleshooting (4.2.1.1)	161
	<i>Data Backup</i>	161
	Identify the Problem (4.2.1.2)	162
	<i>Conversation Etiquette</i>	162
	<i>Open-Ended and Closed-Ended Questions</i>	163
	<i>Documenting Responses</i>	163
	<i>Beep Codes</i>	163
	<i>BIOS Information</i>	164
	<i>Event Viewer</i>	164

	<i>Device Manager</i>	164
	<i>Task Manager</i>	165
	<i>Diagnostic Tools</i>	165
	Establish a Theory of Probable Cause (4.2.1.3)	166
	Test the Theory to Determine Cause (4.2.1.4)	166
	Establish a Plan of Action to Resolve the Problem and Implement the Solution (4.2.1.5)	167
	Verify Full System Functionality and, If Applicable, Implement Preventive Measures (4.2.1.6)	168
	Document Findings, Actions, and Outcomes (4.2.1.7)	168
	PC Common Problems and Solutions (4.2.2.1)	169
	Summary (4.3.1)	175
	Summary of Exercises	175
	Check Your Understanding	175
Chapter 5	Operating Systems	179
	Objectives	179
	Key Terms	179
	Introduction 5.0.1.1	181
	Modern Operating Systems (5.1)	181
	Terms (5.1.1.1)	181
	Basic Functions of an Operating System (5.1.1.2)	181
	<i>Hardware Access</i>	182
	<i>File and Folder Management</i>	182
	<i>User Interface</i>	182
	<i>Application Management</i>	183
	Processor Architecture (5.1.1.3)	183
	Types of Operating Systems (5.1.2)	184
	Desktop Operating Systems (5.1.2.1)	185
	<i>Microsoft Windows</i>	185
	<i>Apple OS X</i>	186
	<i>Linux</i>	186
	Network Operating Systems (5.1.2.2)	186
	Customer Requirements for an Operating System (5.1.3)	187
	OS-Compatible Applications and Environments (5.1.3.1)	187
	Minimum Hardware Requirements and Compatibility with the OS Platform (5.1.3.2)	188
	<i>Microsoft Comparability Center</i>	188
	Comparing OS Requirements (5.1.3.3)	189

Operating System Upgrades (5.1.4) 192

Checking OS Compatibility (5.1.4.1) 192

Upgrade Advisor 192

Windows OS Upgrades (5.1.4.2) 193

Data Migration (5.1.4.3) 195

User State Migration Tool 195

Windows Easy Transfer 195

File and Settings Transfer Wizard for Windows XP 196

Operating System Installation (5.2) 196

Hard Drive Partitioning (5.2.1.1) 196

Partitioning 197

Hard Drive Formatting (5.2.1.2) 198

Quick Format Versus Full Format 200

OS Installation with Default Settings (5.2.1.4) 200

Network Settings 202

Account Creation (5.2.1.8) 203

Complete the Installation (5.2.1.12) 204

Windows Update 205

Device Manager 206

Custom Installation Options (5.2.2) 207

Disk Cloning (5.2.2.1) 207

Other Installation Methods (5.2.2.2) 207

Network Installation 208

PXE Installation 209

Unattended Installation in Windows 7 and Vista 209

Image-Based Installation 210

Remote Installation 210

System Recovery Options (5.2.2.6) 211

System Recovery Options 211

System Image Recovery 213

Automated System Recovery in Windows XP

Professional 214

Factory Recovery Partition 214

Boot Sequence and Registry Files (5.2.3) 214

Windows Boot Process (5.2.3.1) 214

Windows Boot Process 215

Windows Boot Loader and Windows Boot Manager in

Windows 7 and Windows Vista 216

NTLDR and the Windows Boot Menu in Windows

XP 216

NT Kernel 216

Startup Modes (5.2.3.2) 217

Windows Registry (5.2.3.3) 217

Multiboot (5.2.4) 218

Multiboot Procedures (5.2.4.1) 219

BOOTMGR File 219

Disk Management Utility (5.2.4.2) 220

Drive Status 221

Extending Partitions 222

Splitting Partitions 222

Assigning Drive Letters 222

Adding Drives 222

Adding Arrays 223

Directory Structure and File Attributes (5.2) 224

Directory Structures (5.2.5.1) 224

Drive Mapping 224

Mounting a Volume 224

User and System File Locations (5.2.5.2) 225

User File Locations 225

System Folder 225

Fonts 225

Temporary Files 226

Program Files 227

File Extensions and Attributes (5.2.5.3) 227

Application, File, and Folder Properties (5.2.5.4) 228

Application and File Properties 229

Folder Properties 229

Shadow Copy 230

The Windows GUI and Control Panel (5.3) 230

Windows Desktop (5.3.1.1) 230

Gadgets 231

Desktop Properties (5.3.1.2) 232

Start Menu and Taskbar (5.3.1.3) 233

Start Menu 233

Taskbar 234

Task Manager (5.3.1.4) 234

Computer and Windows Explorer (5.3.1.8) 236

Computer 236

Windows Explorer 236

Launching Applications and Opening Files 236

Windows 7 Libraries (5.3.1.9) 237

Install and Uninstall Applications (5.3.1.10) 237

Adding an Application 237
Uninstalling or Changing a Program 238

Control Panel Utilities (5.3.2) 239

Introduction to Control Panel Utilities (5.3.2.1) 239
 User Accounts (5.3.2.2) 241
 User Account Control Settings 241
 Internet Options (5.3.2.6) 242
 Display Settings (5.3.2.10) 243
 Folder Options (5.3.2.11) 245
 General Tab 245
 View Tab 245
 Search Tab 245
 Action Center (5.3.2.12) 245
 Windows Firewall (5.3.2.13) 246
 Power Options (5.3.2.14) 247
 System Utility (5.3.2.15) 248
 Performance Settings 248
 Windows ReadyBoost 249
 Device Manager (5.3.2.19) 250
 Regional and Language Options (5.3.2.23) 252

Administrative Tools (5.3.3) 252

Computer Management (5.3.3.1) 252
 Event Viewer, Component Services, and Data Sources
 (5.3.3.2) 253
 Services (5.3.3.3) 254
 Performance and Windows Memory Diagnostic (5.3.3.4) 255

System Tools (5.3.4) 256

Disk Defragmenter and Disk Error-Checking Tool (5.3.4.1) 256
 Disk Defragmenter 256
 Disk Error-Checking Tool 257
 System Information (5.3.4.5) 258

Accessories (5.3.5) 259

Remote Desktop (5.3.5.1) 259

Control Panel Utilities Unique to Specific Windows Versions (5.3.6) 260

Windows 7 Unique Utilities (5.3.6.1) 261
 HomeGroup 261
 Action Center 261
 Windows Defender 261

<i>RemoteApp and Desktop Connections</i>	262
<i>Troubleshooting</i>	262
Windows Vista Unique Utilities (5.3.6.2)	262
Windows XP Unique Utilities (5.3.6.3)	263
Command-Line Tools (5.3.7)	264
Windows CLI Commands (5.3.7.1)	264
Run Line Utility (5.3.7.3)	265
<i>MSCONFIG</i>	267
Client-Side Virtualization (5.4)	268
Purpose of Virtual Machines (5.4.1.1)	268
Hypervisor: Virtual Machine Manager (5.4.1.2)	269
<i>Windows Virtual PC</i>	269
<i>Windows XP Mode</i>	270
Virtual Machine Requirements (5.4.1.3)	270
Common Preventive Maintenance Techniques for Operating Systems (5.5)	271
Preventive Maintenance Plan Contents (5.5.1.1)	271
<i>Preventive Maintenance Planning</i>	271
<i>Security</i>	272
<i>Startup Programs</i>	272
Updates (5.5.1.5)	273
<i>Device Driver Updates</i>	273
<i>Operating System Updates</i>	273
<i>Firmware Updates</i>	274
Scheduling Tasks (5.5.1.6)	274
<i>Windows Task Scheduler</i>	274
<i>at Command</i>	275
Restore Points (5.5.1.10)	276
Hard Drive Backup (5.5.1.14)	277
<i>Normal Backup</i>	278
<i>Copy Backup</i>	278
<i>Incremental Backup</i>	278
<i>Differential Backup</i>	278
<i>Daily Backup</i>	278
Basic Troubleshooting Process for Operating Systems (5.6)	279
Identify the Problem (5.6.1.1)	279
Establish a Theory of Probable Cause (5.6.1.2)	279
Test the Theory to Determine Cause (5.6.1.3)	280
Establish a Plan of Action to Resolve the Problem and Implement the Solution (5.6.1.4)	280

Verify Full System Functionality and Implement Preventive Measures (5.6.1.5) 281

Document Findings, Actions, and Outcomes (5.6.1.6) 281

Common Problems and Solutions (5.6.2.1) 282

Summary (5.7.1.1) 288

Summary of Exercises 288

Labs 288

Worksheets 291

Check Your Understanding 291

Chapter 6 Networks 295

Objectives 295

Key Terms 295

Introduction (6.0.1) 299

Principles of Networking (6.1) 299

Define Computer Networks (6.1.1.1) 299

Features and Benefits (6.1.1.2) 301

Require Fewer Peripherals 301

Increase Communication Capabilities 301

Avoid File Duplication and Corruption 301

Lower the Cost of Licensing 302

Centralize Administration 302

Conserve Resources 302

Identifying Networks (6.2) 302

LANs (6.2.1.1) 302

WLANs (6.2.1.2) 303

PANs (6.2.1.3) 304

MANs (6.2.1.4) 304

WANs (6.2.1.5) 304

Peer-to-Peer Networks (6.2.1.6) 305

Client/Server Networks (6.2.1.7) 306

Basic Networking Concepts and Technologies (6.3) 307

Bandwidth (6.3.1.1) 307

Data Transmission (6.3.1.2) 308

Simplex 308

Half-Duplex 309

Full-Duplex 309

IP Addressing (6.3.2.1)	309
<i>IPv4 and IPv6</i>	310
IPv4 (6.3.2.2)	311
<i>IPv4 Subnet Mask</i>	312
IPv6 (6.3.2.3)	313
Static Addressing (6.3.2.4)	314
DHCP Addressing (6.3.2.5)	315
<i>Configuring Alternate IP Settings</i>	317
<i>DNS</i>	317
ICMP (6.3.2.6)	317
Common Ports and Protocols (6.3.3)	319
TCP and UDP (6.3.3.1)	319
TCP and UDP Protocols and Ports (6.3.3.3)	320
Physical Components of a Network (6.4)	322
Modems (6.4.1.1)	322
Hubs, Bridges, and Switches (6.4.1.2)	323
<i>Hubs</i>	323
<i>Bridges and Switches</i>	324
<i>Power over Ethernet</i>	325
Routers and Wireless Access Points (6.4.1.3)	325
<i>Wireless Access Points</i>	325
<i>Routers</i>	326
<i>Multipurpose Devices</i>	326
NAS (6.4.1.4)	327
VoIP Phones (6.4.1.5)	327
Hardware Firewalls (6.4.1.6)	328
Internet Appliances (6.4.1.7)	329
Purchasing Authentic Networking Devices (6.4.1.8)	329
Cables and Connectors (6.4.2)	330
Considerations for Cabling a Network (6.4.2.1)	330
<i>Cost</i>	331
<i>Security</i>	331
<i>Design for the Future</i>	331
<i>Wireless</i>	331
Coaxial Cables (6.4.2.2)	332
Twisted-Pair Cables (6.4.2.3)	332
<i>Category Rating</i>	333
<i>Wire Schemes</i>	334
<i>Straight-Through Cables</i>	335
<i>Crossover Cable</i>	335
Fiber-Optic Cables (6.4.2.6)	336

Network Topologies (6.5) 337

Logical and Physical Topologies (6.5.1.1) 337

Bus 338*Ring* 339*Star* 339*Hierarchical* 339*Mesh* 339*Hybrid* 339

Determining the Network Topology (6.5.1.3) 340

Ethernet Standards (6.6) 341

Standards Organizations (6.6.1.1) 341

IEEE 802.3 (6.6.1.2) 342

Ethernet Technologies (6.6.1.3) 342

IEEE 802.11 (6.6.1.4) 343

OSI and TCP/IP Data Models (6.7) 343

TCP/IP (6.7.1.1) 343

Application Layer Protocols 344*Transport Layer Protocols* 344*Internet Layer Protocols* 344*Network Access Layer Protocols* 345

OSI (6.7.1.2) 345

Comparing the OSI and TCP/IP Models (6.7.1.3) 346

Computer-to-Network Connection (6.8) 347

Network Installation Completion List (6.8.1.1) 347

Selecting a NIC (6.8.2.1) 348

Installing and Updating a NIC (6.8.2.3) 350

Configuring a NIC (6.8.2.7) 351

Configure Alternate IP Settings 352

Advanced NIC Settings (6.8.2.8) 352

Duplex and Speed 352*Wake on LAN* 353*Quality of Service* 353**Wireless and Wired Router Configurations (6.8.3) 353**

Connecting to the Router (6.8.3.1) 353

Setting the Network Location (6.8.3.2) 354

Logging In to the Router (6.8.3.3) 356

Basic Network Setup (6.8.3.4) 356

Basic Wireless Settings (6.8.3.7) 358

Network Mode 358*SSID* 358

<i>Channel</i>	359
<i>Wireless Security</i>	359
Testing Connectivity with the Windows GUI (6.8.3.12)	360
Testing Connectivity with the Windows CLI (6.8.3.13)	361
<i>ipconfig Command Options</i>	362
<i>ping Command Options</i>	362
<i>net Commands</i>	363
<i>tracert Command</i>	364
<i>nslookup Command</i>	364
OS Configurations (6.8.4)	365
Domain and Workgroup (6.8.4.1)	365
<i>Domain</i>	365
<i>Workgroup</i>	366
Connecting to a Workgroup or a Domain (6.8.4.2)	366
Windows 7 Homegroup (6.8.4.3)	366
Sharing Resources in Windows Vista (6.8.4.4)	368
Sharing Resources in Windows XP (6.8.4.5)	369
Network Shares and Mapping Drives (6.8.4.6)	369
<i>Network File Sharing</i>	369
<i>Network Drive Mapping</i>	370
VPN (6.8.4.10)	371
Select an ISP Connection Type (6.9)	372
Brief History of Connection Technologies (6.9.1.1)	372
<i>Analog Telephone</i>	373
<i>Integrated Services Digital Network</i>	373
<i>Broadband</i>	373
DSL and ADSL (6.9.1.2)	373
Line-of-Sight Wireless Internet Service (6.9.1.3)	374
WiMAX (6.9.1.4)	374
Other Broadband Technologies (6.9.1.5)	375
<i>Cellular</i>	375
<i>Cable</i>	376
<i>Satellite</i>	376
<i>Fiber Broadband</i>	376
Selecting an ISP for the Customer (6.9.1.7)	376
<i>POTS</i>	377
<i>ISDN</i>	378
<i>DSL</i>	378
<i>Cable</i>	378
<i>Satellite</i>	378
<i>Cellular</i>	378

Common Preventive Maintenance Techniques Used for Networks (6.10) 379

Preventive Maintenance Procedures (6.10.1.1) 379

Basic Troubleshooting Process for Networks (6.11) 380

Identify the Problem (6.11.1.1) 380

Establish a Theory of Probable Cause (6.11.1.2) 381

Test the Theory to Determine Cause (6.11.1.3) 381

Establish a Plan of Action to Resolve the Problem and
Implement the Solution (6.11.1.4) 381

Verify Full System Functionality and Implement Preventive
Measures (6.11.1.5) 382

Document Findings, Actions, and Outcomes (6.11.1.6) 382

Common Problems and Solutions for Networks (6.11.2) 383

Identify Common Problems and Solutions (6.11.2.1) 383

Summary (6.12.1) 385**Summary of Exercises 387**

Labs 387

Worksheets 387

Packet Tracer Activities 388

Check Your Understanding 388**Chapter 7****Laptops 393****Objectives 393****Key Terms 393****Introduction (7.0.1.1) 395****Laptop Components (7.1) 395**

External Features Unique to Laptops (7.1.1.1) 395

Common Input Devices and LEDs in Laptops (7.1.1.2) 399

Internal Components (7.1.1.3) 401

Motherboards 401

RAM 401

CPUs 402

Special Function Keys (7.1.1.4) 402

Docking Station Versus Port Replicator (7.1.1.5) 403

Laptop Display Components (7.2) 405

LCD, LED, OLED, and Plasma Monitors (7.2.1.1) 406

Internal Components (7.2.2) 406

Backlights and Inverters (7.2.2.1) 406

Wi-Fi Antenna Connectors (7.2.2.2) 407

Laptop Power (7.3) 408

Power Management (7.3.1.1) 408

Managing ACPI Settings in the BIOS (7.3.1.2) 409

Managing Laptop Power Options (7.3.1.4) 410

Laptop Power Options 410

Hard Drive and Display Power Management 411

Sleep Timers 412

Battery Warnings 412

Laptop Wireless Communication Technologies (7.4) 413

Bluetooth (7.4.1.1) 413

Bluetooth Installation and Configuration 414

Infrared (7.4.1.2) 415

Cellular WAN (7.4.1.3) 417

Wi-Fi (7.4.1.4) 417

Laptop Hardware and Component Installation and Configuration (7.5) 419

Expansion Cards (7.5.1.1) 419

Flash Memory (7.5.1.2) 421

External Flash Drive 421

Flash Cards and Flash Card Readers 421

SODIMM Memory (7.5.1.3) 422

Replacing Hardware Devices (7.5.2) 424

Overview of Hardware Replacement (7.5.2.1) 424

Power (7.5.2.2) 426

Replacing a Battery 427

Replacing a DC Jack 427

Keyboard, Touchpad, and Screen (7.5.2.4) 428

Replacing a Keyboard 429

Replacing a Touchpad 429

Replacing a Screen 430

Hard Drive and Optical Drive (7.5.2.6) 431

Replacing a Hard Drive 431

Replacing an Optical Drive 432

Wireless Card (7.5.2.8) 433

Speakers (7.5.2.9) 433

CPU (7.5.2.10) 434

System Board (7.5.2.11) 436

Plastics (7.5.2.12) 436

Preventive Maintenance Techniques for Laptops (7.6) 437

Scheduling Maintenance (7.6.1.1) 437

Preventive Maintenance Program 437

Cleaning Procedures (7.6.1.2) 439

Keyboard 439

Vents 439

LCD Display 440

Touchpad 440

Optical Drive 440

CD and DVD Discs 440

Basic Troubleshooting Process for Laptops (7.7) 441

Identify the Problem (7.7.1.1) 441

Establish a Theory of Probable Cause (7.7.1.2) 441

Test the Theory to Determine Cause (7.7.1.3) 442

Establish a Plan of Action to Resolve the Problem and
Implement the Solution (7.7.1.4) 442

Verify Full System Functionality and Implement Preventive
Measures (7.7.1.5) 443

Document Findings, Actions, and Outcomes (7.7.1.6) 443

Identify Common Problems and Solutions (7.7.2.1) 443

Summary (7.8.1) 447

Summary of Exercises 448

Worksheets 448

Virtual Laptop Activities 448

Check Your Understanding 449

Chapter 8 Mobile Devices 451

Objectives 451

Key Terms 451

Introduction (8.0.1) 454

Mobile Device Hardware Overview (8.1) 454

Non-Field-Serviceable Parts (8.1.1.1) 454

Non-Upgradeable Hardware (8.1.1.2) 455

Touchscreens (8.1.1.3) 456

Solid State Drives (8.1.1.4) 457

Mobile Operating Systems (8.2) 458

Open Source Versus Closed Source (8.2.1.1) 458

Application and Content Sources (8.2.1.2) 459

Push Versus Pull 460

Sideload 460

Android Touch Interface (8.2.2) 461

Home Screen Items (8.2.2.1) 461

Navigation Icons 461

Google Search 462

Special Enhancements 462

Notification and System Icons 462

TouchFLO 463

Managing Apps, Widgets, and Folders (8.2.2.2) 463

Apps 464

Widgets 464

Folders 465

All Apps Icon 466

iOS Touch Interface (8.2.3) 466

Home Screen Items (8.2.3.1) 466

Home Button 467

Notification Center 467

Search 468

Managing Apps and Folders (8.2.3.2) 468

Apps 468

Multitasking Bar 469

Folders 469

Common Mobile Device Features (8.2.4) 470

Screen Orientation and Calibration (8.2.4.1) 470

Screen Orientation 470

Screen Calibration 471

GPS (8.2.4.2) 472

Network Connectivity and Email (8.3) 473

Wireless Data Network (8.3.1.1) 473

Cellular Communications (8.3.1.3) 475

WiMAX and LTE 476

Airplane Mode 476

Bluetooth for Mobile Devices (8.3.2.1) 477

Bluetooth Pairing (8.3.2.2) 477

Introduction to Email (8.3.3.1) 479

POP3 479

IMAP 480

SMTP	480
MIME	480
SSL	480
Exchange	480
Android Email Configuration (8.3.3.3)	481
iOS Email Configuration (8.3.3.4)	481
Mobile Device Synchronization (8.3.4)	482
Types of Data to Synchronize (8.3.4.1)	482
Application Installation Software Requirements (8.3.4.2)	483
Synchronization Connection Types (8.3.4.3)	484
Cross-Platform Data Synchronization	484
Methods for Securing Mobile Devices (8.4)	485
Overview of Passcode Locks (8.4.1.1)	485
Restrictions on Failed Login Attempts (8.4.1.3)	486
Cloud-Enabled Services for Smart Devices (8.4.2)	487
Remote Backup (8.4.2.1)	487
Locator Applications (8.4.2.2)	488
Remote Lock and Remote Wipe (8.4.2.3)	489
Software Security (8.4.3)	490
Antivirus (8.4.3.1)	490
Rooting and Jailbreaking	490
Patching and Updating Operating Systems (8.4.3.2)	491
Applying the Troubleshooting Process to Mobile Devices (8.5.1)	492
Identify the Problem (8.5.1.1)	492
Establish a Theory of Probable Cause (8.5.1.2)	493
Test the Theory to Determine Cause (8.5.1.3)	493
Establish a Plan of Action to Resolve the Problem and Implement the Solution (8.5.1.4)	494
Verify Full System Functionality and Implement Preventive Measures (8.5.1.5)	494
Document Findings, Actions, and Outcomes (8.5.1.6)	494
Identify Common Problems and Solutions (8.5.2.1)	495
Summary (8.6.1)	498
Summary of Exercises	499
Labs	499
Worksheets	499
Check Your Understanding	499

Chapter 9	Printers	503
	Objectives	503
	Key Terms	503
	Introduction (9.0.1)	504
	Common Printer Features (9.1)	504
	Characteristics and Capabilities of Printers (9.1.1.1)	504
	<i>Capabilities and Speed</i>	505
	<i>Color or Black and White</i>	505
	<i>Quality</i>	505
	<i>Reliability</i>	505
	<i>Total Cost of Ownership</i>	506
	Wired Printer Connection Types (9.1.1.2)	506
	<i>Serial</i>	506
	<i>Parallel</i>	507
	<i>SCSI</i>	507
	<i>USB</i>	507
	<i>FireWire</i>	507
	<i>Ethernet</i>	507
	Types of Printers (9.2)	507
	Inkjet Printers (9.2.1.1)	508
	Laser Printers (9.2.1.2)	509
	<i>Printing Process</i>	509
	Thermal Printers (9.2.1.3)	511
	Impact Printers (9.2.1.4)	511
	<i>Types of Impact Printers</i>	512
	Installing and Configuring Printers (9.3)	513
	Installing a Printer (9.3.1.1)	513
	Types of Print Drivers (9.3.1.5)	514
	Updating and Installing Print Drivers (9.3.1.6)	515
	Printer Test Page (9.3.1.7)	516
	<i>Print Test Page</i>	516
	<i>Print from an Application</i>	517
	<i>Test the Printer</i>	517
	<i>Test the Printer from the Printer Panel</i>	518
	Configuring Options and Default Settings (9.3.2)	518
	Common Configuration Settings (9.3.2.1)	518
	Global and Individual Document Options (9.3.2.2)	520
	<i>Global Method</i>	520
	<i>Per Document Method</i>	520

Optimizing Printer Performance (9.3.3) 520

Software Optimization (9.3.3.1) 521

Hardware Optimization (9.3.3.2) 521

Firmware 521*Printer Memory* 521*Additional Printer Upgrades* 522**Sharing Printers (9.4) 523**

Configuring Printer Sharing (9.4.1.1) 523

Wireless Printer Connections (9.4.1.2) 525

Print Servers (9.4.2) 526

Purposes of Print Servers (9.4.2.1) 526

Network, Dedicated, and Computer Shared Print Servers
(9.4.2.2) 526*Hardware Print Servers* 526*Dedicated PC Print Servers* 527*Computer-Shared Printers* 527**Preventive Maintenance Techniques for Printers (9.5) 528**

Vendor Guidelines (9.5.1.1) 528

Replacing Consumables (9.5.1.2) 529

Cleaning Methods (9.5.1.3) 530

Printer Maintenance 531

Operational Environment (9.5.1.4) 532

Basic Troubleshooting Process for Printers (9.6) 532

Identify the Problem (9.6.1.1) 533

Establish a Theory of Probable Cause (9.6.1.2) 533

Test the Theory to Determine Cause (9.6.1.3) 534

Establish a Plan of Action to Resolve the Problem and
Implement the Solution (9.6.1.4) 534Verify Full System Functionality and Implement Preventive
Measures (9.6.1.5) 535

Document Findings, Actions, and Outcomes (9.6.1.6) 535

Common Problems and Solutions for Printers (9.6.2) 536

Identify Common Problems and Solutions (9.6.2.1) 536

Summary (9.7.1.1) 537**Summary of Exercises 537**

Labs 538

Worksheets 538

Check Your Understanding 538

Chapter 10 Security 541

Objectives 541

Key Terms 541

Introduction (10.0.1) 544

Security Threats (10.1) 545

Adware, Spyware, and Phishing (10.1.1.1) 545

Adware 545

Spyware 545

Grayware 545

Phishing 545

Viruses, Worms, Trojans, and Rootkits (10.1.1.2) 546

Viruses 546

Worms 546

Trojans 546

Virus Protection Software 547

Rootkits 547

Web Security (10.1.1.3) 547

ActiveX Filtering 548

Pop-Up Blocker 548

SmartScreen Filter 549

InPrivate Browsing (10.1.1.4) 550

Spam (10.1.1.5) 551

TCP/IP Attacks (10.1.1.6) 552

Denial of Service 552

Distributed DoS 552

SYN Flood 552

Spoofing 553

Man-in-the-Middle 553

Replay 553

DNS Poisoning 553

Social Engineering (10.1.2.1) 554

Data Wiping, Hard Drive Destruction, and Recycling (10.1.2.2) 554

Data Wiping 555

Degaussing 555

Hard Drive Destruction 556

Solid State Drives 556

Hard Drive Recycling 556

Security Procedures (10.2) 556

What Is a Security Policy? (10.2.1.1) 557

Security Policy Requirements (10.2.1.3) 557

Usernames and Passwords (10.2.1.4)	559
<i>Requiring Passwords</i>	559
Password Requirements (10.2.1.5)	560
<i>Screensaver Required Password</i>	561
File and Folder Permissions (10.2.1.6)	561
<i>Principle of Least Privilege</i>	564
<i>Restricting User Permissions</i>	565
Software Firewalls (10.2.2.1)	565
Biometrics and Smart Cards (10.2.2.2)	567
<i>Smart Card Security</i>	568
<i>Security Key Fob</i>	568
Data Backups (10.2.2.3)	568
Data Encryption (10.2.2.4)	569
Malicious Software Protection Programs (10.2.3.1)	571
<i>Rogue Antivirus</i>	571
<i>Remediating Infected Systems</i>	572
Signature File Updates (10.2.3.3)	573
Common Communication Encryption Types (10.2.4.1)	575
<i>Hash Encoding</i>	575
<i>Symmetric Encryption</i>	575
<i>Asymmetric Encryption</i>	576
Service Set Identifiers (10.2.4.2)	577
MAC Address Filtering (10.2.4.3)	578
Wireless Security Modes (10.2.4.4)	578
<i>Additions to WPA and WPA2</i>	579
Wireless Access (10.2.4.6)	579
<i>Wireless Antennae</i>	580
<i>Network Device Access</i>	580
<i>Wi-Fi Protected Setup</i>	581
Firewalls (10.2.4.7)	581
<i>Demilitarized Zone</i>	582
Port Forwarding and Port Triggering (10.2.4.9)	583
Physical Equipment Protection Methods (10.2.5.1)	585
<i>Disabling AutoRun</i>	585
<i>Two-Factor Authentication</i>	586
Security Hardware (10.2.5.2)	586
<i>Protecting Data While in Use</i>	587
<i>The Right Security Mix</i>	588
Security Maintenance (10.3.1)	589
Operating System Service Packs and Security Patches (10.3.1.1)	589

Data Backups (10.3.1.3) 591

Configuring Firewall Types (10.3.1.7) 593

Maintaining Accounts (10.3.1.11) 595

Terminating Employee Access 595

Guest Accounts 595

Applying the Troubleshooting Process to Security (10.4.1) 596

Identify the Problem (10.4.1.1) 596

Establish a Theory of Probable Cause (10.4.1.2) 597

Test the Theory to Determine Cause (10.4.1.3) 597

Establish a Plan of Action to Resolve the Problem and
Implement the Solution (10.4.1.4) 598

Verify Full System Functionality and, If Applicable, Implement
Preventive Measures (10.4.1.5) 598

Document Findings, Actions, and Outcomes (10.4.1.6) 599

Identify Common Problems and Solutions (10.4.2.1) 599

Summary (10.5.1.1) 602

Summary of Exercises 602

Labs 602

Worksheets 603

Check Your Understanding 603

Chapter 11 The IT Professional 607

Objectives 607

Key Terms 607

Introduction (11.0.1) 608

Communication Skills and the IT Professional (11.1) 608

Relationship Between Communication Skills and
Troubleshooting (11.1.1.1) 608

Relationship Between Communication Skills and Professional
Behavior (11.1.1.2) 609

Working with a Customer (11.1.2) 610

Using Communication Skills to Determine Customer Problems
(11.1.2.1) 610

Displaying Professional Behavior with Customers (11.1.2.2) 611

Keeping the Customer Focused on the Problem (11.1.2.5) 613

Talkative Customers 613

Rude Customers 613

Angry Customers 614

Knowledgeable Customers 614
Inexperienced Customers 615
 Using Proper Netiquette (11.1.2.6) 615

Employee Best Practices (11.1.3) 616

Time and Stress Management Techniques (11.1.3.1) 616
 Workstation Ergonomics 616
 Time Management 616
 Stress Management 617
 Observing Service Level Agreements (11.1.3.2) 618
 Following Business Policies (11.1.3.3) 619
 Customer Call Rules 619
 Call Center Employee Rules 619
 Customer Satisfaction 620

Ethical and Legal Issues in the IT Industry (11.2) 620

Ethical Considerations in IT (11.2.1.1) 620
 Legal Considerations in IT (11.2.1.2) 621

Legal Procedures Overview (11.2.2) 621

Computer Forensics (11.2.2.1) 622
 Cyber Law and First Response (11.2.2.2) 622
 Cyber Law 622
 First Response 623
 Documentation and Chain of Custody (11.2.2.3) 623
 Documentation 624
 Chain of Custody 624

Call Center Technicians (11.3) 625

Call Centers (11.3.1.1) 625
 Level One Technician Responsibilities (11.3.1.2) 626
 Level Two Technician Responsibilities (11.3.1.3) 627

Summary (11.4.1) 628

Summary of Exercises 629

Worksheets 629

Check Your Understanding 629

Chapter 12 Advanced Troubleshooting 633

Objectives 633

Key Terms 633

Introduction (12.0.1) 634

Apply Troubleshooting Process to Computer Components and Peripherals (12.1.1) 634

Six Steps for Advanced Troubleshooting Computer Components and Peripherals (12.1.1.1) 634

Common Problems and Solutions for Components and Peripherals (12.1.1.2) 637

Apply Troubleshooting Skills to Computer Components and Peripherals (12.1.1.3) 639

Operating Systems (12.2) 641

Six Steps for Advanced Troubleshooting Operating Systems (12.2.1.1) 641

Common Problems and Solutions for Operating Systems (12.2.1.2) 643

Apply Troubleshooting Skills to Operating Systems (12.2.1.3) 648

Apply Troubleshooting Process to Networks (12.3.1) 650

Six Steps for Advanced Troubleshooting Networks (12.3.1.1) 650

Common Problems and Solutions for Networks (12.3.1.2) 652
Network Connection Problems 652

Email Failure 654

FTP and Secure Internet Connection Problems 654

Problems Revealed by CLI Commands 655

Apply Troubleshooting Skills to Networks (12.3.1.3) 656

Apply Troubleshooting Process to Laptops (12.4.1) 658

Six Steps for Advanced Troubleshooting Laptops (12.4.1.1) 658

Common Problems and Solutions for Laptops (12.4.1.2) 661

Apply Troubleshooting Skills to Laptops (12.4.1.3) 664

Apply Troubleshooting Process to Printers (12.5.1) 665

Six Steps for Advanced Troubleshooting Printers (12.5.1.1) 665

Common Problems and Solutions for Printers (12.5.1.2) 668

Apply Troubleshooting Skills to Printers (12.5.1.3) 669

Apply Troubleshooting Process to Security (12.6.1) 670

Six Steps for Advanced Troubleshooting Security (12.6.1.1) 670

Common Problems and Solutions for Security (12.6.1.2) 673

Malware Settings 673

User Accounts and Permissions 674

Computer Security 674

Firewall and Proxy Settings 675

Apply Troubleshooting Skills to Security (12.6.1.3) 676

Summary (12.7.1) 678

Summary of Exercises 678

Labs 678

Check Your Understanding 679

Appendix A Answers to “Check Your Understanding” Questions 683

Glossary 699

Index 737

Introduction

IT Essentials: PC Hardware and Software Companion Guide, Fifth Edition, is a supplemental book to the Cisco Networking Academy IT Essentials: PC Hardware and Software Version 5 course. The course teaches you how to build a computer and troubleshoot problems that occur in everyday use. The course is designed to prepare you to take and pass the CompTIA A+ exams (based on the 2012 objectives). By reading and completing this book, you have the opportunity to review all key concepts that the CompTIA A+ exams cover. If you use this book along with its companion, *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition (ISBN 1-58713-310-5), you can reinforce those concepts with hands-on exercises and test that knowledge with review questions and exercises.

The IT Essentials: PC Hardware and Software course aligns with the CompTIA A+ (220-801) exam and CompTIA A+ (220-802) exam. You must pass both exams to earn the CompTIA A+ certification.

Who Should Read This Book

This book is intended for students in the Cisco Networking Academy IT Essentials: PC Hardware and Software Version 5 course. This student is usually pursuing a career in information technology (IT) or wants to have the knowledge of how a computer works, how to assemble a computer, and how to troubleshoot hardware and software issues.

Book Features

The features in this book facilitate an understanding of computer systems and troubleshooting system problems. The highlights of each chapter are as follows:

- **Objectives:** Each chapter starts with a list of objectives that should be mastered by the end of the chapter. The objectives are framed as focus questions addressing the concepts covered in the chapter.
- **Key terms:** Each chapter includes a list of the key terms identified in the chapter, listed in the order in which they appear in the chapter. These terms serve as a study aid and are defined in the book's Glossary. The key terms reinforce the concepts introduced in the chapter and help you understand the chapter material before you move on to new concepts. You can find the key terms highlighted in blue throughout the chapter, in the context in which they are most important.

- **Explanatory text, lists, figures, and tables:** This book contains figures, procedures, and tables to accompany the thorough text explanations of the objective content and to help explain and visualize theories, concepts, commands, and setup sequences.
- **Chapter summaries:** At the end of each chapter is a summary of the concepts covered in the chapter. The summary provides a synopsis of the chapter and serves as a study aid.
- **Lab, worksheet, and class discussion references:** There are references to the labs, worksheets, and class discussion exercises that can be found in the accompanying *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition (ISBN 1-58713-310-5).
- **Virtual Desktop activity and Virtual Laptop activity references:** Designed and developed by the Cisco Networking Academy, these activities are virtual learning tools to help you develop critical thinking and complex problem-solving skills. How to access these activities is discussed in the following section, “Accessing Packet Tracer, Virtual Laptop, and Virtual Desktop Activities.”
- **Packet Tracer activities:** Cisco Packet Tracer simulation-based learning activity files promote the exploration of networking and network security concepts and enable you to experiment with network behavior. How to access these activities is discussed in the following section, “Accessing Packet Tracer, Virtual Laptop, and Virtual Desktop Activities.”
- **“Check Your Understanding” review questions:** Review questions are presented at the end of each chapter to serve as an assessment. In addition, the questions reinforce the concepts introduced in the chapter and help test your understanding before you move on to subsequent chapters. Answers to the questions are available in the Appendix.

Accessing Packet Tracer, Virtual Laptop, and Virtual Desktop Activities

All the Packet Tracer activities, Virtual Laptop, and Virtual Desktop activities are available within your IT Essentials Version 5 course in Netspace. However, you can also get easy access just to these activities if you register this Companion Guide on the Cisco Press website. Please visit <http://ciscopress.com/register>, create an account, and register your book. Once you have an account and have registered your book, follow the Access Bonus Content link to view the downloadable activities.

Note that you need to have the Packet Tracer software to use these Packet Tracer activity files. Packet Tracer is available only through the Cisco Networking Academy. Ask your instructor for a copy of this software. Also note that the most current files will always be found within the course on Netspace. Access to these files on the Cisco Press site is intended only for convenience of access for those of you using the Companion Guide textbook accompanying your course.

How This Book Is Organized

This book corresponds closely to the Cisco IT Essentials course and is divided into 12 chapters, one appendix, and a glossary of key terms:

- **Chapter 1, “Introduction to the Personal Computer”:** Information technology (IT) is the design, development, implementation, support, and management of computer hardware and software applications. A computer is an electronic machine that performs calculations based on a set of instructions. A computer system consists of hardware and software components. This chapter discusses hardware components found in a computer system, selecting replacement computer components, and configurations for specialized computer systems.
- **Chapter 2, “Lab Procedures and Tool Use”:** This chapter covers basic safety practices for the workplace, hardware and software tools, and the disposal of hazardous materials. Safety guidelines help protect individuals from accidents and injury and protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination by discarded materials. You will also learn how to protect equipment and data and how to properly use hand and software tools.
- **Chapter 3, “Computer Assembly”:** Assembling computers is a large part of a technician’s job. As a technician, you must work in a logical, methodical manner when working with computer components. At times, you might have to determine whether a component for a customer’s computer needs to be upgraded or replaced. It is important that you develop advanced skills in installation procedures, troubleshooting techniques, and diagnostic methods. This chapter discusses the importance of component compatibility across hardware and software.
- **Chapter 4, “Overview of Preventive Maintenance”:** Troubleshooting is the systematic process used to locate the cause of a fault in a computer system and correct the relevant hardware and software issues. In this chapter, you will learn general guidelines for creating preventive maintenance programs and troubleshooting procedures. These guidelines are a starting point to help you develop your preventive maintenance and troubleshooting skills.

- **Chapter 5, “Operating Systems”:** The operating system (OS) controls almost all functions on a computer. In this chapter, you learn about the components, functions, and terminology related to the Windows 2000, Windows XP, Windows Vista, and Windows 7 operating systems.
- **Chapter 6, “Networks”:** This chapter provides an overview of network principles, standards, and purposes. The different types of network topologies, protocols, and logical models, in addition to the hardware needed to create a network, are also discussed in this chapter. Configuration, troubleshooting, and preventive maintenance are covered. You also learn about network software, communication methods, and hardware relationships.
- **Chapter 7, “Laptops”:** With the increase in demand for mobility, the popularity of mobile devices will continue to grow. During the course of your career, you will be expected to know how to configure, repair, and maintain these devices. The knowledge you acquire about desktop computers will help you service laptops and portable devices. However, there are important differences between the two technologies. This chapter examines these differences and how to techniques to use specific to laptops.
- **Chapter 8, “Mobile Devices”:** A mobile device is any device that is handheld, is light, and typically uses a touchscreen for input. Like a desktop or laptop computer, mobile devices use an operating system to run applications (apps) and games and play movies and music. It is important to become familiar with as many different mobile devices as possible. You may be required to know how to configure, maintain, and repair various mobile devices. Mastering the skills necessary to work on mobile devices is important to your career advancement. This chapter focuses on the many features of mobile devices and their capabilities, including configuration, synchronization, and data backup.
- **Chapter 9, “Printers”:** This chapter provides essential information about printers. You will learn how printers operate, what to consider when purchasing a printer, and how to connect printers to an individual computer or to a network.
- **Chapter 10, “Security”:** Technicians need to understand computer and network security. Failure to implement proper security procedures can have an impact on users, computers, and the general public. Private information, company secrets, financial data, computer equipment, and items of national security are placed at risk if proper security procedures are not followed. This chapter covers why security is important, security threats, security procedures, how to troubleshoot security issues, and how you can work with customers to ensure that the best possible protection is in place.

- **Chapter 11, “The IT Professional”:** As a computer technician, you not only fix computers, but also interact with people. In fact, troubleshooting is as much about communicating with the customer as it is about knowing how to fix a computer. In this chapter, you learn to use good communication skills as confidently as you use a screwdriver.
- **Chapter 12, “Advanced Troubleshooting”:** In your career as a technician, it is important that you develop advanced skills in troubleshooting techniques and diagnostic methods for computer components, operating systems, networks, laptops, printers, and security issues. Advanced troubleshooting can sometimes mean that the problem is unique or that the solution is difficult to perform. In this chapter, you will learn how to apply a troubleshooting process to solve computer problems.
- **Appendix A, “Answers to ‘Check Your Understanding’ Questions”:** This appendix lists the answers to the “Check Your Understanding” review questions that are included at the end of each chapter.
- **Glossary:** The Glossary provides you with definitions for all the key terms identified in each chapter.

About the CompTIA A+ Certification

As a CompTIA Authorized Quality Curriculum, IT Essentials: PC Hardware and Software v5 will help prepare you for the new CompTIA A+ Essentials and Practical Applications certification exams. To become A+ certified, you need to pass two exams to become certified in your chosen career area:

- CompTIA A+ (220-801)
- CompTIA A+ (220-802)

After becoming certified, you will be qualified to work as a computer support professional and technician in a variety of work environments and industries.

The CompTIA A+ exam is explained in detail, including a list of the objectives, at the following website:

<http://www.comptia.org/certifications/listed/a.aspx>

When you are ready to take the exam, you must purchase and schedule your two CompTIA A+ exams. You can find the necessary information to accomplish this at the following website:

<http://certification.comptia.org/getCertified/certifications/a.aspx>

Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a show command).
- *Italic* indicates arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets ([]) indicate an optional element.
- Braces ({ }) indicate a required choice.
- Braces within brackets ([{ }]) indicate a required choice within an optional element.

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Lab Procedures and Tool Use

Objectives

Upon completion of this chapter, you will be able to answer the following questions:

- What are safe working conditions and procedures?
- What procedures help protect equipment and data?
- What procedures help to properly dispose of hazardous computer components and related material?
- What tools and software are used with personal computer components, and what is their purpose?
- What is proper tool use?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

electrostatic discharge (ESD) page 79

antistatic wrist strap page 80

electromagnetic interference (EMI) page 80

radio frequency interference (RFI) page 80

current page 80

power fluctuation page 80

blackout page 80

brownout page 81

noise page 81

spike page 81

power surge page 81

power protection device page 81

surge suppressor page 81

uninterruptible power supply page 81

standby power supply (SPS) page 81

Material Safety and Data Sheet (MSDS)
page 82

*Occupational Safety and Health
Administration (OSHA)* page 82

*Registration, Evaluation, Authorization and
restriction of Chemicals (REACH)* page 83

antistatic mat page 85

hand tools page 85

flat-head screwdriver page 85

Phillips-head screwdriver page 85

hex driver page 86

Torx screwdriver page 86

part retriever page 86

wire stripper page 86

crimper page 86

punch-down tool page 86

cleaning tools page 86

diagnostic tools page 86

digital multimeter page 86

loopback adapter page 87

toner probe page 87

external hard drive enclosure page 87

disk management tool page 88

format page 88

ScanDisk page 88

CHKDSK page 88

defrag page 88

Disk Cleanup page 88

System File Checker (SFC) page 88

Windows 7 Action Center page 89

antispyware program page 89

Windows 7 Firewall page 89

personal reference tools page 90

antistatic bags page 97

power supply tester page 97

cable tester page 97

loopback plug page 97

Introduction (2.0.1)

This chapter covers basic safety practices for the workplace, hardware and software tools, and the disposal of hazardous materials. Safety guidelines help protect individuals from accidents and injury. They also help to protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination caused by improperly discarded materials. You will also learn how to protect equipment and data and how to properly use hand and software tools.

Safe Lab Procedures (2.1)

This section discusses safety in the lab. Safety guidelines help protect individuals from accidents and injury. They also help to protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination caused by improperly discarded materials.

General Safety (2.1.1.1)

Safe working conditions help prevent injury to people and damage to computer equipment. A safe workspace is clean, organized, and properly lighted. Everyone must understand and follow safety procedures.

Follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. As a best practice, make sure that a fire extinguisher and first-aid kit are available in case of fire or injury. Poorly placed or unsecured cables can cause tripping hazards in a network installation. Cables should be installed in conduit or cable trays to prevent hazards.

This is a partial list of basic safety precautions to use when working on a computer:

- Remove your watch and jewelry and secure loose clothing.
- Turn off the power and unplug equipment before performing service.
- Cover sharp edges inside the computer case with tape.
- Never open a power supply or a CRT monitor.
- Do not touch areas in printers that are hot or that use high voltage.
- Know where the fire extinguisher is located and how to use it.
- Keep food and drinks out of your workspace.
- Keep your workspace clean and free of clutter.
- Bend your knees when lifting heavy objects to avoid injuring your back.

Electrical Safety (2.1.1.2)

Follow electrical safety guidelines to prevent electrical fires, injuries, and fatalities in the home and the workplace. Power supplies and CRT monitors contain high voltage.

Caution

Only experienced technicians should attempt to repair power supplies and CRT monitors. Do not wear the antistatic wrist strap when repairing power supplies or CRT monitors.

Some printer parts become hot during use, and other parts might contain high voltage. Check the printer manual for the location of high-voltage components. Some components retain a high voltage even after the printer is turned off. Make sure that the printer has had time to cool before making the repair.

Electrical devices have certain power requirements. For example, AC adapters are manufactured for specific laptops. Exchanging power cords with a different type of laptop or device may cause damage to both the AC adapter and the laptop.

Fire Safety (2.1.1.3)

Follow fire safety guidelines to protect lives, structures, and equipment. To avoid an electrical shock and to prevent damage to the computer, turn off and unplug the computer before beginning a repair.

Fire can spread rapidly and be very costly. Proper use of a fire extinguisher can prevent a small fire from getting out of control. When working with computer components, be aware of the possibility of an accidental fire and know how to react. Be alert for odors emitting from computers and electronic devices. When electronic components overheat or short out, they emit a burning odor. If there is a fire, follow these safety procedures:

- Never fight a fire that is out of control or not contained.
- Always have a planned fire escape route before beginning any work.
- Get out of the building quickly.
- Contact emergency services for help.
- Locate and read the instructions on the fire extinguishers in your workplace before you have to use them.

Be familiar with the types of fire extinguishers used in your country or region. Each type of fire extinguisher has specific chemicals to fight different types of fires:

- Paper, wood, plastics, cardboard
- Gasoline, kerosene, organic solvents

- Electrical equipment
- Combustible metals

It is important to know how to use a fire extinguisher. Use the memory aid P-A-S-S to remember the basic rules of fire extinguisher operation:

- **P:** Pull the pin.
- **A:** Aim at the base of the fire, not at the flames.
- **S:** Squeeze the lever.
- **S:** Sweep the nozzle from side to side.

Procedures to Protect Equipment and Data (2.1.2)

Replacing equipment and recovering data is expensive and time consuming. This section identifies potential threats to systems and describes procedures to help prevent loss and damage.

ESD and EMI (2.1.2.1)

Electrostatic discharge (ESD), harsh climates, and poor-quality sources of electricity can cause damage to computer equipment. Follow proper handling guidelines, be aware of environmental issues, and use equipment that stabilizes power to prevent equipment damage and data loss.

Static electricity is the buildup of an electric charge resting on a surface.

Electrostatic discharge (ESD) occurs when this buildup jumps to a component and causes damage. ESD can be destructive to the electronics in a computer system.

At least 3000 volts of static electricity must build up before a person can feel ESD. For example, static electricity can build up on you as you walk across a carpeted floor. When you touch another person, you both receive a shock. If the discharge causes pain or makes a noise, the charge was probably above 10,000 volts. By comparison, less than 30 volts of static electricity can damage a computer component.

ESD can cause permanent damage to electrical components. Follow these recommendations to help prevent ESD damage:

- Keep all components in antistatic bags until you are ready to install them.
- Use grounded mats on workbenches.

- Use grounded floor mats in work areas.
- Use *antistatic wrist straps* when working on computers.

Electromagnetic interference (EMI) is the intrusion of outside electromagnetic signals in a transmission media, such as copper cabling. In a network environment, EMI distorts the signals so that the receiving devices have difficulty interpreting them.

EMI does not always come from expected sources, such as cellular phones. Other types of electric equipment can emit a silent, invisible electromagnetic field that can extend for more than a mile (1.6 km).

There are many sources of EMI:

- Any source designed to generate electromagnetic energy
- Manmade sources like power lines or motors
- Natural events such as electrical storms, or solar and interstellar radiations

Wireless networks are affected by *radio frequency interference (RFI)*. RFI is caused by radio transmitters and other devices transmitting in the same frequency. For example, a cordless telephone can cause problems with a wireless network when both devices use the same frequency. Microwaves can also cause interference when positioned in close proximity to wireless networking devices.

Climate

Climate affects computer equipment in a variety of ways:

- If the environment temperature is too high, equipment can overheat.
- If the humidity level is too low, the chance of ESD increases.
- If the humidity level is too high, equipment can suffer from moisture damage.

Power Fluctuation Types (2.1.2.2)

Voltage is the force that moves electrons through a circuit. The movement of electrons is called *current*. Computer circuits need voltage and current to operate electronic components. When the voltage in a computer is not accurate or steady, computer components might not operate correctly. Unsteady voltages are called *power fluctuations*.

The following types of AC power fluctuations can cause data loss or hardware failure:

- **Blackout:** Complete loss of AC power. A blown fuse, damaged transformer, or downed power line can cause a blackout.

- **Brownout:** Reduced voltage level of AC power that lasts for a period of time. Brownouts occur when the power line voltage drops below 80 percent of the normal voltage level. Overloading electrical circuits can cause a brownout.
- **Noise:** Interference from generators and lightning. Noise results in poor quality power, which can cause errors in a computer system.
- **Spike:** Sudden increase in voltage that lasts for a short period and exceeds 100 percent of the normal voltage on a line. Spikes can be caused by lightning strikes but can also occur when the electrical system comes back on after a blackout.
- **Power surge:** Dramatic increase in voltage above the normal flow of electrical current. A power surge lasts for a few nanoseconds, or one-billionth of a second.

Power Protection Devices (2.1.2.3)

To help shield against power fluctuation problems, use *power protection devices* to protect the data and computer equipment:

- **Surge suppressor:** Helps protect against damage from surges and spikes. A surge suppressor diverts extra electrical voltage that is on the line to the ground.
- **Uninterruptible power supply (UPS):** Helps protect against potential electrical power problems by supplying a consistent level of electrical power to a computer or other device. The battery is constantly recharging while the UPS is in use. The UPS provides a consistent quality of power when brownouts and blackouts occur. Many UPS devices can communicate directly with the computer operating system. This communication allows the UPS to safely shut down the computer and save data prior to the UPS losing all electrical power.
- **Standby power supply (SPS):** Helps protect against potential electrical power problems by providing a backup battery to supply power when the incoming voltage drops below the normal level. The battery is on standby during normal operation. When the voltage decreases, the battery provides DC power to a power inverter, which converts it to AC power for the computer. This device is not as reliable as a UPS because of the time it takes to switch over to the battery. If the switching device fails, the battery cannot supply power to the computer.

Caution

UPS manufacturers suggest never plugging in a laser printer to a UPS because the printer could overload the UPS.

Procedures to Protect the Environment (2.1.3)

Most computers and peripherals use and contain at least some materials that can be considered toxic to the environment. This section describes tools and procedures that help identify these materials and the steps for the proper handling and disposal of the materials.

Material Safety and Data Sheet (2.1.3.1)

Computers and peripherals contain materials that can be harmful to the environment. Hazardous materials are sometimes called toxic waste. These materials can contain high concentrations of heavy metals such as cadmium, lead, or mercury. The regulations for the disposal of hazardous materials vary by state or country. Contact the local recycling or waste removal authorities in your community for information about disposal procedures and services.

A *Material Safety and Data Sheet (MSDS)* is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first-aid requirements. The MSDS contains chemical reactivity and incompatibility information. It also includes protective measures for the safe handling and storage of materials and spill, leak, and disposal procedures.

To determine whether a material is classified as hazardous, consult the manufacturer’s MSDS. In the United States, the *Occupational Safety and Health Administration (OSHA)* requires that all hazardous materials be accompanied by an MSDS when transferred to a new owner. The MSDS information included with products purchased for computer repairs or maintenance can be relevant to computer technicians. OSHA also requires that employees be informed about the materials that they are working with and be provided with material safety information. Figure 2-1 shows the OSHA website where you can find the MSDS form and more information.

The screenshot shows the OSHA website interface. At the top, it says "UNITED STATES DEPARTMENT OF LABOR" and "OSHA". Below this, there's a navigation bar with links like "Home", "Workers", "Regulations", "Enforcement", "Data & Statistics", "Training", "Publications", "Revisions", and "Small Business". The main content area is titled "Material Safety Data Sheet" and includes a note about OSHA's Hazard Communication Standard. Below this, there's a section labeled "Section I" with fields for "Manufacturer's Name", "Address", "Emergency Telephone Number", and "Telephone Number for Information".

Figure 2-1 MSDS

Note

The MSDS is valuable in determining how to dispose of potentially hazardous materials in the safest manner. Always check local regulations concerning acceptable disposal methods before disposing of any electronic equipment.

The MSDS contains valuable information:

- Name of the material
- Physical properties of the material
- Hazardous ingredients contained in the material
- Reactivity data, such as fire and explosion data
- Procedures for spills and leaks
- Special precautions
- Health hazards
- Special protection requirements

In the European Union, the regulation *Registration, Evaluation, Authorization and restriction of Chemicals (REACH)* came into effect on June 1, 2007, replacing various directives and regulations with a single system.

Equipment Disposal (2.1.3.2)

The proper disposal or recycling of hazardous computer components is a global issue. Make sure to follow regulations that govern how to dispose of specific items. Organizations that violate these regulations can be fined or face expensive legal battles.

Batteries

Batteries often contain rare earth metals that can be harmful to the environment. Batteries from portable computer systems can contain lead, cadmium, lithium, alkaline manganese, and mercury. These metals do not decay and remain in the environment for many years. Mercury is commonly used in the manufacturing of batteries and is extremely toxic and harmful to humans.

Recycling batteries should be a standard practice for a technician. All batteries, including lithium-ion, nickel-cadmium, nickel-metal hydride, and lead-acid, are subject to disposal procedures that comply with local environmental regulations.

Monitors

Monitors contain glass, metal, plastics, lead, barium, and rare earth metals. According to the U.S. Environmental Protection Agency (EPA), monitors can contain approximately 4 pounds (1.8 kg) of lead. Monitors must be disposed of in compliance with environmental regulations.

Handle CRT monitors with care. Extremely high voltage can be stored in CRT monitors, even after being disconnected from a power source.

Toner Kits, Cartridges, and Developers

Used printer toner kits and printer cartridges must be disposed of properly or recycled. Some toner cartridge suppliers and manufacturers take empty cartridges for refilling. Some companies specialize in refilling empty cartridges. Kits to refill inkjet printer cartridges are available but are not recommended because the ink might leak into the printer, causing irreparable damage. Using refilled inkjet cartridges might also void the inkjet printer warranty.

Chemical Solvents and Aerosol Cans

Contact the local sanitation company to learn how and where to dispose of the chemicals and solvents used to clean computers. Never dump chemicals or solvents down a sink or dispose of them in a drain that connects to public sewers.

The cans or bottles that contain solvents and other cleaning supplies must be handled carefully. Make sure that they are identified and treated as special hazardous waste. For example, some aerosol cans explode when exposed to heat if the contents are not completely used.

Proper Use of Tools (2.2)

Using tools properly helps prevent accidents and damage to equipment and people. This section describes and covers the proper use of a variety of hardware, software, and organizational tools specific to working with computers and peripherals.

Hardware Tools (2.2.1)

For every job there is the right tool. Make sure that you are familiar with the correct use of each tool and that the correct tool is used for the current task. Skilled use of tools and software makes the job less difficult and ensures that tasks are performed properly and safely.

A toolkit should contain all the tools necessary to complete hardware repairs. As you gain experience, you learn which tools to have available for different types of jobs. Hardware tools are grouped into four categories:

- ESD tools
- Hand tools
- Cleaning tools
- Diagnostic tools

Figure 2-2 shows some common tools used in computer repair.



Figure 2-2 Computer Tools

ESD Tools (2.2.1.2)

There are two ESD tools: the antistatic wrist strap and the *antistatic mat*. The antistatic wrist strap protects computer equipment when grounded to a computer chassis. The antistatic mat protects computer equipment by preventing static electricity from accumulating on the hardware or on the technician.

Hand Tools (2.2.1.3)

Most tools used in the computer assembly process are small *hand tools*. They are available individually or as part of a computer repair toolkit. Toolkits range widely in size, quality, and price. Some common hand tools and their uses are

- *Flat-head screwdriver*: Used to tighten or loosen slotted screws.
- *Phillips-head screwdriver*: Used to tighten or loosen cross-headed screws.

- **Torx screwdriver:** Used to tighten or loosen screws that have a star-like depression on the top, a feature that is mainly found on laptops.
- **Hex driver:** Used to tighten or loosen nuts in the same way that a screwdriver tightens or loosens screws (sometimes called a nut driver).
- **Needle-nose pliers:** Used to hold small parts.
- **Wire cutters:** Used to strip and cut wires.
- **Tweezers:** Used to manipulate small parts.
- **Part retriever:** Used to retrieve parts from locations that are too small for your hand to fit.
- **Flashlight:** Used to light up areas that you cannot see well.
- **Wire stripper:** A wire stripper is used to remove the insulation from wire so that it can be twisted to other wires or crimped to connectors to make a cable.
- **Crimper:** Used to attach connectors to wires.
- **Punch-down tool:** Used to terminate wire into termination blocks. Some cable connectors must be connected to cables using a punch down tool.

Cleaning Tools (2.2.1.4)

Having the appropriate *cleaning tools* is essential when maintaining and repairing computers. Using the appropriate cleaning tools helps ensure that computer components are not damaged during cleaning. Cleaning tools include the following:

- **Soft cloth:** Used to clean different computer components without scratching or leaving debris
- **Compressed air:** Used to blow away dust and debris from different computer parts without touching the components
- **Cable ties:** Used to bundle cables neatly inside and outside of a computer
- **Parts organizer:** Used to hold screws, jumpers, fasteners, and other small parts and prevents them from getting mixed together

Diagnostic Tools (2.2.1.5)

Diagnostic tools are used to test and diagnose equipment. Diagnostic tools include the following:

- A *digital multimeter*, as shown in Figure 2-3, is a device that can take many types of measurements. It tests the integrity of circuits and the quality of electricity in computer components. A digital multimeter displays the information on an LCD or LED.



Figure 2-3 Multimeter

- A *loopback adapter*, also called a loopback plug, tests the basic functionality of computer ports. The adapter is specific to the port that you want to test.
- The *toner probe*, as shown in Figure 2-4, is a two-part tool. The toner part is connected to a cable at one end using specific adapters, such as an RJ-45, coaxial, or metal clips. The toner generates a tone that travels the length of the cable. The probe part traces the cable. When the probe is in near proximity to the cable to which the toner is attached, the tone can be heard through a speaker in the probe.



Figure 2-4 Toner Probe

Although an *external hard drive enclosure* is not a diagnostic tool, it is often used when diagnosing and repairing computers. The customer hard drive is placed into the external enclosure for inspection, diagnosis, and repair using a known-working computer. Backups can also be recorded to a drive in an external enclosure to prevent data corruption during a computer repair.

Software Tools (2.2.2)

Like hardware tools, there are a variety of software tools that can be used to help technicians pinpoint and troubleshoot problems. Many of these tools are free and several come with the Windows operating system.

Disk Management Tools (2.2.2.1)

Software tools help diagnose computer and network problems and determine which computer device is not functioning correctly. A technician must be able to use a range of software tools to diagnose problems, maintain hardware, and protect the data stored on a computer.

You must be able to identify which software to use in different situations. *Disk management tools* help detect and correct disk errors, prepare a disk for data storage, and remove unwanted files.

The following are some disk management tools:

- **FDISK:** A command-line tool that creates and deletes partitions on a hard drive. The FDISK tool is not available in Windows XP, Vista, or 7. It has been replaced with the Disk Management tool.
- **Disk Management Tool:** Initializes disks, creates partitions, and formats partitions.
- *Format:* Prepares a hard drive to store information.
- *ScanDisk or CHKDSK:* Checks the integrity of files and folders on a hard drive by scanning the file system. These tools might also check the disk surface for physical errors.
- *Defrag:* Optimizes space on a hard drive to allow faster access to programs and data.
- *Disk Cleanup:* Clears space on a hard drive by searching for files that can be safely deleted.
- *System File Checker (SFC):* A command-line tool that scans the operating system critical files and replaces files that are corrupted.

Use the Windows 7 boot disk for troubleshooting and repairing corrupted files. The Windows 7 boot disk repairs Windows system files, restores damaged or lost files, and reinstalls the operating system.

Third-party software tools are also available to assist in troubleshooting problems.

Protection Software Tools (2.2.2.2)

Each year, viruses, spyware, and other types of malicious attacks infect millions of computers. These attacks can damage operating systems, applications, and data. Computers that have been infected may even have problems with hardware performance or component failure.

To protect data and the integrity of the operating system and hardware, use software designed to guard against attacks and to remove malicious programs.

Various types of software protect hardware and data:

- **Windows 7 Action Center:** Checks the status of essential security settings. The Action Center continuously checks to make sure that the software firewall and antivirus programs are running. It also ensures that automatic updates download and install automatically.
- **Antivirus program:** Protects against virus attacks.
- **Antispyware program:** Protects against software that sends information about web surfing habits to an attacker. Spyware can be installed without the knowledge or consent of the user.
- **Windows 7 Firewall:** Runs continuously to protect against unauthorized communications to and from your computer.



Worksheet 2.2.2.3: Diagnostic Software

In this worksheet, you use the Internet, a newspaper, or a local store to gather information about a hard drive diagnostic program. Be prepared to discuss the diagnostic software you researched. Refer to the worksheet in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Organizational Tools (2.2.3)

Keeping accurate records and journals during a busy workday can be challenging. Many organizational tools, such as work-order systems, can help the technician document their work.

Reference Tools (2.2.3.1)

A technician must document all repairs and computer problems. The documentation can then be used as a reference for future problems or for other technicians who may not have encountered the problem before. The documents can be paper based, but electronic forms are preferred because they can be easily searched for specific problems.

It is important that a technician document all services and repairs. These documents need to be stored centrally and made available to all other technicians. The documentation can then be used as reference material for similar problems that are encountered in the future. Good customer service includes providing the customer with a detailed description of the problem and the solution.

Personal Reference Tools

Personal reference tools include troubleshooting guides, manufacturer manuals, quick reference guides, and repair journals. In addition to an invoice, a technician keeps a journal of upgrades and repairs. The documentation in the journal includes descriptions of the problem, possible solutions that have been attempted, and the steps taken to repair the problem. Note any configuration changes made to the equipment and any replacement parts used in the repair. This documentation is valuable when you encounter similar situations in the future.

- **Notes:** Make notes as you go through the troubleshooting and repair process. Refer to these notes to avoid repeating previous steps and to determine what steps to take next.
- **Journal:** Document the upgrades and repairs that you perform. Include descriptions of the problem, possible solutions that have been tried to correct the problem, and the steps taken to repair the problem. Note any configuration changes made to the equipment and any replacement parts used in the repair. Your journal, along with your notes, can be valuable when you encounter similar situations in the future.
- **History of repairs:** Make a detailed list of problems and repairs, including the date, replacement parts, and customer information. The history allows a technician to determine what work has been performed on a specific computer in the past.

Internet Reference Tools

The Internet is an excellent source of information about specific hardware problems and possible solutions:

- Internet search engines
- News groups
- Manufacturer FAQs
- Online computer manuals
- Online forums and chat
- Technical websites

Miscellaneous Tools (2.2.3.2)

With experience, you will discover many additional items to add to the toolkit. Figure 2-5 shows how a roll of masking tape can be used to label parts that have been removed from a computer when a parts organizer is not available.



Figure 2-5 Parts Labels

A working computer is also a valuable resource to take with you on computer repairs in the field. A working computer can be used to research information, download tools or drivers, and communicate with other technicians.

Figure 2-6 shows the types of computer replacement parts to include in a toolkit. Make sure that the parts are in good working order before you use them. Using known good components to replace possible bad ones in computers helps you quickly determine which component is not working properly.

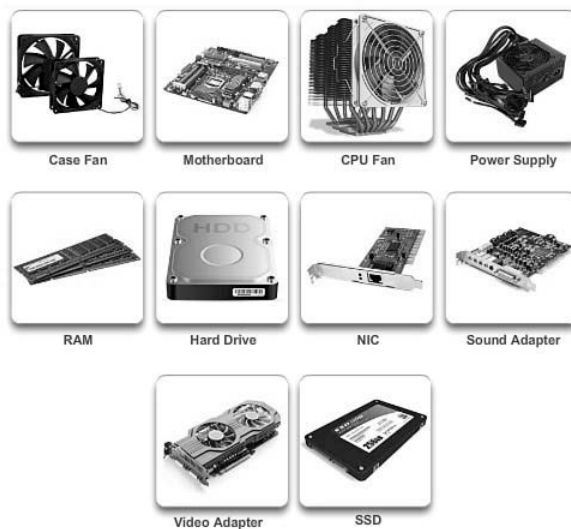


Figure 2-6 Replacement Computer Parts

Demonstrate Proper Tool Use (2.2.4)

This section describes the proper use of common tools used to protect, repair, and clean computers and peripherals.

Antistatic Wrist Strap (2.2.4.1)

Safety in the workplace is everyone's responsibility. You are much less likely to injure yourself or damage components when using the proper tool for the job.

Before cleaning or repairing equipment, make sure that your tools are in good condition. Clean, repair, or replace items that are not functioning adequately.

An example of ESD is the small shock that you receive when you walk across a carpeted room and touch a doorknob. Although the small shock is harmless to you, the same electrical charge passing from you to a computer can damage its components. Self-grounding or wearing an antistatic wrist strap can prevent ESD damage to computer components.

The purpose of self-grounding or wearing an antistatic wrist strap is to equalize the electrical charge between you and the equipment. Self-grounding is done by touching a bare metal part of a computer case. The antistatic wrist strap is a conductor that connects your body to the equipment that you are working on. When static electricity builds up in your body, the connection made by the wrist strap to the equipment, or ground, channels the electricity through the wire that connects the strap.

As shown in Figure 2-7, the wrist strap has two parts and is easy to wear. Following is the proper procedure for using an antistatic wrist strap:



- Step 1.** Wrap the strap around your wrist and secure it using the snap or Velcro. The metal on the back of the wrist strap must remain in contact with your skin at all times.
- Step 2.** Snap the connector on the end of the wire to the wrist strap, and connect the other end either to the equipment or to the same grounding point that the antistatic mat is connected to. The metal skeleton of the case is a good place to connect the wire. When connecting the wire to equipment that you are working on, choose an unpainted metal surface. A painted surface does not conduct electricity as well as unpainted metal.



Figure 2-7 Antistatic Wrist Strap

Note

Attach the wire on the same side of the equipment as the arm wearing the antistatic wrist strap. This helps keep the wire out of the way while you are working.

Although wearing a wrist strap helps prevent ESD, you can further reduce the risks by not wearing clothing made of silk, polyester, or wool. These fabrics are more likely to generate a static charge.

Note

Technicians should roll up their sleeves, remove scarves or ties, and tuck in shirts to prevent interference from clothing. Ensure that earrings, necklaces, and other loose jewelry are properly secured.

Caution

Never wear an antistatic wrist strap if you are repairing a CRT monitor or a power supply unit.

Antistatic Mat (2.2.4.2)

You might not always have the option to work on a computer in a properly equipped workspace. If you can control the environment, try to set up your workspace away from carpeted areas. Carpets can cause the buildup of electrostatic charges. If you cannot avoid the carpeting, ground yourself to the unpainted portion of the case of the computer on which you are working before touching any components.

An antistatic mat is slightly conductive. It works by drawing static electricity away from a component and transferring it safely from equipment to a grounding point, as shown in Figure 2-8. Following is the proper procedure for using an antistatic mat:

How To

- Step 1.** Lay the mat on the workspace next to or under the computer case.
- Step 2.** Clip the mat to the case to provide a grounded surface on which you can place parts as you remove them from the system.



Figure 2-8 Antistatic Mat

When you are working at a workbench, ground the workbench and the antistatic floor mat. By standing on the mat and wearing the wrist strap, your body has the same charge as the equipment and reduces the probability of ESD. Either connect the table-top mat and the floor mat to each other or connect both to the electrical earth ground.

Reducing the potential for ESD reduces the likelihood of damage to delicate circuits or components.

Note

Always handle components by the edges.

Hand Tools (2.2.4.3)

A technician needs to be able to properly use each tool in the toolkit. This topic covers many of the various hand tools used when repairing computers.

Screws

Match each screw with the proper screwdriver. Place the tip of the screwdriver on the head of the screw. Turn the screwdriver clockwise to tighten the screw and counterclockwise to loosen the screw.

Screws can become stripped if you over-tighten them with a screwdriver. A stripped screw, as shown in Figure 2-9, may get stuck in the screw hole, or it may not tighten firmly. Discard stripped screws.

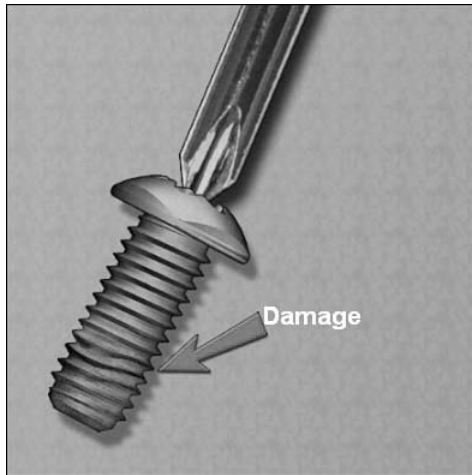


Figure 2-9 Stripped Screw

Flat-Head Screwdriver

Use a flat-head screwdriver when you are working with a slotted screw. Do not use a flat-head screwdriver to remove a Phillips-head screw. Never use a screwdriver as a pry bar. If you cannot remove a component, check to see if there is a clip or latch that is securing the component in place.

Caution

If excessive force is needed to remove or add a component, something is probably wrong. Take a second look to make sure that you have not missed a screw or a locking clip that is holding the component in place. Refer to the device manual or diagram for additional information.

Phillips-Head Screwdriver

Use a Phillips-head screwdriver with crosshead screws. Do not use this type of screwdriver to puncture anything. This will damage the head of the screwdriver.

Hex Driver

Use a hex driver, shown in Figure 2-10, to loosen and tighten bolts that have a hexagonal (six-sided) head. Hex bolts should not be over-tightened because the threads of the bolts can be stripped. Do not use a hex driver that is too large for the bolt that you are using.



Figure 2-10 Hex Driver

Caution

Some tools are magnetized. When working around electronic devices, be sure that the tools you are using have not been magnetized. Magnetic fields can be harmful to data stored on magnetic media. Test your tool by touching the tool with a screw. If the screw is attracted to the tool, do not use the tool.

Component Retrieving Tools

Needle-nose pliers and tweezers can be used to place and retrieve parts that may be hard to reach with your fingers. There are also tools called part retrievers that are specifically designed for this task. Do not scratch or hit any components when using these tools.

Caution

Pencils should not be used inside the computer to change the setting of switches or to pry off jumpers. The pencil lead can act as a conductor and may damage the computer components.

A computer technician needs proper tools to work safely and prevent damage to the computer equipment. A technician uses many tools to diagnose and repair computer problems:

- Straight-head screwdriver, large and small
- Phillips-head screwdriver, large and small
- Tweezers or part retriever
- Needle-nosed pliers
- Wire cutters
- Chip extractor

- Hex wrench set
- Torx screwdriver
- Nut driver, large and small
- Three-claw component holder
- Wire stripper
- Crimper
- Punch-down tool
- Digital multimeter
- Wrap plugs
- Small mirror
- Small dust brush
- Soft, lint-free cloth
- Cable ties
- Scissors
- Small flashlight
- Electrical tape
- Pencil or pen
- Compressed air

Various specialty tools, such as Torx bits, *antistatic bags* and gloves, and integrated circuit pullers, can be used to repair and maintain computers. Always avoid magnetized tools, such as screwdrivers with magnetic heads, or tools that use extension magnets to retrieve small metal objects that are out of reach. Using magnetic tools can cause loss of data on hard drives and floppy disks. Magnetic tools can also induce current, which can damage internal computer components.

Additionally, there are specialized testing devices used to diagnose computer and cable problems:

- **Multimeter:** A device that measures AC/DC voltage, electric current, and other cable and electrical characteristics.
- **Power supply tester:** A device that checks whether the computer power supply is working properly. A simple power supply tester might just have indicator lights, while more advanced versions show the amount of voltage and amperage.
- **Cable tester:** A device that checks for wiring shorts or faults, such as wires connected to the wrong pin.
- **Loopback plug:** A device that connects to a computer, hub, switch, or router port to perform a diagnostic procedure called a loopback test. In a loopback test, a signal is transmitted through a circuit and then returned to the sending device to test the integrity of the data transmission.



Lab 2.2.4.4: Using a Multimeter and a Power Supply Tester

In this lab, you learn how to use and handle a multimeter and a power supply tester. Refer to Lab 2.2.4.4 in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

**Lab 2.2.4.5: Testing UTP Cables Using a Loopback Plug and a Cable Meter**

In this lab, you use a loopback plug and a cable meter to test an Ethernet cable. Refer to Lab 2.2.4.5 in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Cleaning Materials (2.2.4.6)

Keeping computers clean inside and out is a vital part of a maintenance program. Dirt can cause problems with the physical operation of fans, buttons, and other mechanical components. On electrical components, an excessive buildup of dust acts like an insulator and traps the heat. This insulation impairs the ability of heat sinks and cooling fans to keep components cool, causing chips and circuits to overheat and fail.

Note

When using compressed air to clean inside the computer, blow the air around the components with a minimum distance of 4 in. (10 cm) from the nozzle. Clean the power supply and the fan from the back of the case.

Caution

Before cleaning any device, turn it off and unplug the device from the power source.

Computer Cases and Monitors

Clean computer cases and the outside of monitors with a mild cleaning solution on a damp, lint-free cloth. Mix one drop of dishwashing liquid with 4 oz. (118 ml) of water to create the cleaning solution. If water drips inside the case, allow enough time for the liquid to dry before powering on the computer.

LCD Screens

Do not use ammoniated glass cleaners or any other solution on an LCD screen, unless the cleaner is specifically designed for the purpose. Harsh chemicals damage the coating on the screen. There is no glass protecting these screens, so be gentle when cleaning them and do not press firmly on the screen.

CRT Screens

To clean the screens of CRT monitors, dampen a soft, clean, lint-free cloth with distilled water and wipe the screen from top to bottom. Then use a soft, dry cloth to wipe the screen and remove streaking.

Components

Clean dusty components with a can of compressed air. Compressed air does not cause electrostatic buildup on components. Make sure that you are in a well-ventilated area before blowing the dust out of the computer. A best practice is to wear a dust mask to make sure that you do not breathe in the dust particles.

Blow out the dust using short bursts from the can. Never tip the can or use the can upside down. Do not allow the fan blades to spin from the force of the compressed air. Hold the fan in place. Fan motors can be ruined from spinning when the motor is not turned on.

Component Contacts

Clean the contacts on components with isopropyl alcohol. Do not use rubbing alcohol. Rubbing alcohol contains impurities that can damage contacts. Make sure that the contacts do not collect lint from the cloth or cotton swab. Before reinstallation, use compressed air to blow lint off the contacts.

Keyboards

Clean a desktop keyboard with compressed air and then use a handheld vacuum cleaner with a brush attachment to remove the loose dust.

Caution

Never use a standard vacuum cleaner inside a computer case. The plastic parts of the vacuum cleaner can build up static electricity and discharge to the components. Use only vacuums that are approved for electronic components.

Mice

Use glass cleaner and a soft cloth to clean the outside of the mouse. Do not spray glass cleaner directly on the mouse. If cleaning a ball mouse, you can remove the ball and clean it with glass cleaner and a soft cloth. Wipe the rollers clean inside the mouse with the same cloth. Do not spray any liquids inside the mouse.

Table 2-1 shows the computer items that you should clean and the cleaning materials to use.

Table 2-1 Computer Cleaning Materials

Computer case and outside of monitor	Mild cleaning solution and lint-free cloth
LCD screen	LCD cleaning solution or distilled water and lint-free cloth
CRT screen	Distilled water and lint-free cloth

Heat sink	Compressed air
RAM	Isopropyl alcohol and lint-free swab
Keyboard	Handheld vacuum cleaner with a brush attachment
Mouse	Glass cleaner and a soft cloth

**Lab 2.2.4.7: Computer Disassembly**

In this lab, you disassemble a computer using safe lab procedures and the proper tools. Use extreme care and follow all safety procedures. Familiarize yourself with the tools you will be using in this lab. Refer to Lab 2.2.4.7 in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Summary (2.3.1)

This chapter discussed safe lab procedures, correct tool usage, and the proper disposal of computer components and supplies. You have familiarized yourself in the lab with many of the tools used to build, service, and clean computer and electronic components. You have also learned the importance of organizational tools and how these tools help you work more efficiently.

Some of the important concepts to remember from this chapter:

- Work in a safe manner to protect users and equipment.
- Follow all safety guidelines to prevent injuries to yourself and others.
- Know how to protect equipment from ESD damage.
- Know about and be able to prevent power issues that can cause equipment damage or data loss.
- Know which products and supplies require special disposal procedures.
- Familiarize yourself with the MSDS for safety issues and disposal restrictions to help protect the environment.
- Be able to use the correct tools for the task.
- Know how to clean components safely.
- Use organizational tools during computer repairs.

Summary of Exercises

The following labs and worksheets cover material from this chapter. Refer to the labs and worksheets in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition:

Lab 2.2.4.4: Using a Multimeter and a Power Supply Tester

Lab 2.2.4.5: Testing UTP Cables Using a Loopback Plug and a Cable Meter

Lab 2.2.4.7: Computer Disassembly



Worksheets

The following worksheets cover material from this chapter. Refer to the worksheets in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition:

Worksheet 2.2.2.3: Diagnostic Software

Check Your Understanding

You can find the answers to these questions in Appendix A, “Answers to ‘Check Your Understanding’ Questions.”

1. How should a technician discharge static buildup while working on a computer system?
 - A. Maintain contact with the painted part of the computer case.
 - B. Maintain contact with an unpainted part of the computer case.
 - C. Touch an antistatic wrist strap before touching any computer equipment.
 - D. Touch an antistatic mat before touching any computer equipment.
2. Which of the following is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first aid requirements?
 - A. ESD
 - B. MSDS
 - C. OSHA
 - D. UPS
3. Which two statements are true of static electricity? (Choose two.)
 - A. It can distort wireless signals.
 - B. More than 10,000 volts can build up on a person.
 - C. As few as 30 volts can damage computer components.
 - E. It will not harm computer components as long as the computer is plugged in.
 - F. Keeping the air cool and dry can decrease the buildup of static electricity.
 - G. It is generated by devices such as motors, power lines, and radio transmitters.

4. Which recommendation should be followed first when a fire in the workplace is out of control?
 - A. Try to use the elevators to get to the lowest floor faster.
 - B. Get out of the room or building and contact emergency services for help.
 - C. Use the company water system to stop the fire from extending to other areas.
 - D. Try to control the fire with proper extinguishers.
5. Which device is designed specifically to protect computers and electrical devices from excess electrical voltage?
 - A. Power strip
 - B. Standby power supply
 - C. Surge protector
 - D. Uninterruptible power supply
6. Which piece of software is designed to protect against unauthorized communications to and from a computer?
 - A. Security center
 - B. Port scanner
 - C. Antimalware
 - D. Antivirus
 - E. Firewall
7. What is an accepted method for cleaning computer components?
 - A. Using ammonia to clean the LCD screen
 - B. Using rubbing alcohol to clean component contacts
 - C. Using a lint-free cloth to remove dust inside the computer case
 - D. Using glass cleaner on a soft cloth to clean the outside of the mouse
8. Which tool would be used to scan Windows critical system files and replace any corrupted files?
 - A. SFC
 - B. CHKDSK
 - C. Fdisk
 - D. Defrag

- 9. Which condition refers to a sudden and dramatic increase in voltage, which is usually caused by lightning?
 - A. Brownout
 - B. Sag
 - C. Spike
 - D. Surge

- 10. Which tool can be used to take resistance and voltage measurements?
 - A. Multimeter
 - B. Power supply tester
 - C. Cable tester
 - D. Loopback plug

Symbols

- 1G cellular WANs, 375
- 2G cellular WANs, 375
- 2.5G cellular WANs, 375
- 2.5G digital standards, 475
- 3DES (Triple Data Encryption Standard), 575
- 3G cellular WANs, 375
- 3.5G cellular WANs, 375
- 4G cellular WANs, 375
- 4-pin auxiliary power connector, 7
- 6/8-pin PCIe power connector, 7
- 8-pin auxiliary power connector, 7
- 10BASE5 coaxial cable, 332
- 20-pin slotted connector, 7
- 24-pin slotted connector, 7

A

- AC (alternating current) power, 4, 6
- AC power adapters, laptops, 396
- AC power connectors, docking stations, 404
- Accelerated Graphics Port (AGP) expansion slots, 24
- accelerometers, mobile devices, 471
- accounts
 - guest, 595
 - maintaining, 595-596
 - operating systems, creating, 203-204
 - troubleshooting, 674
- ACPI (Advanced Configuration and Power Interface), laptops, 408-410
- Action Center (Control Panel), 245-246, 262
- active partitions, 197
- ActiveX, 548
- adapter cards, 22-23, 115
 - inspecting, 159
 - NICs, installing, 116
 - selecting, 54-57

- video, installing, 117-118
- wireless NICs, installing, 116-117
- Add/Remove Programs utility (Windows XP), 264
- address bus, 51
- Adleman, Leonard, 576
- Administrative Tools, 252
 - Component Services, 254
 - Computer Management console, 252-253
 - Data Sources, 254
 - Event Viewer, 253
 - Performance Monitor, 255-256
 - Services console, 254
 - Windows Memory Diagnostic, 255-256
- Adobe Flash, 548
- Adobe PostScript, 510, 515
- ADSL (asymmetric digital subscriber line), 374
- Advanced Configuration and Power Interface (ACPI), laptops, 408-410
- Advanced Encryption Standard (AES), 359, 579
- Advanced Power Management (APM), laptops, 408
- advanced settings, NICs, 352-353
- Advanced tab (Internet Options), 242
- Advanced Technology Attachment (ATA) interface, 28
- Advanced Technology Extended (ATX) main power connector, 118
- advanced troubleshooting, 634, 678
 - computer components, 634-640
 - common problems and solutions*, 637-639
 - documentation*, 637
 - full system functionality verification*, 636
 - identifying problem*, 634
 - implementing solutions*, 636
 - testing theory*, 635
 - theory of probable cause*, 635
 - laptops, 658, 664
 - common problems and solutions*, 661-663
 - documentation*, 660
 - full system functionality verification*, 660
 - identifying problems*, 658
 - implementing solutions*, 659

- testing theory*, 659
- theory of probable cause*, 658
- operating systems, 641, 648-650, 656-657
 - common problems and solutions*, 643-648, 652-656
 - documentation*, 643, 652
 - full system functionality verification*, 642, 651
 - identifying problems*, 641, 650
 - implementing solutions*, 642, 651
 - testing theory*, 642
 - theory of probable cause*, 641, 650-651
- peripherals, 634-640
 - common problems and solutions*, 637-639
 - documentation*, 637
 - full system functionality verification*, 636
 - identifying problem*, 634
 - implementing solutions*, 636
 - testing theory*, 635
 - theory of probable cause*, 635
- printers, 665, 669-670
 - common problems and solutions*, 668
 - documentation*, 667
 - identifying problem*, 665
 - implementing solutions*, 666
 - testing theory*, 666
 - theory of probable cause*, 665
- security, 676-677
 - common problems and solutions*, 673-675
 - documentation*, 672
 - full system functionality verification*, 672
 - identifying problems*, 670
 - implementing solution*, 671
 - testing theory*, 671
 - theory of probable cause*, 671
- adware, 545
- aerosol cans, proper disposal, 84
- AES (Advanced Encryption Standard), 359, 579
- AGP (Accelerated Graphics Port) expansion slots, 24
- AIK (Automated Installation Kit), 210
- Airplane Mode (mobile devices), 476
- alert badges (iOS), 470
- algorithms
 - backoff, 342
 - Secure Hash Algorithm (SHA), 575
- All Apps icon (Android home screen), 466
- all-in-one devices, 518
 - printers, 46
- alternating current (AC) power, 4, 6
- American National Standards Institute (ANSI), 341
- analog telephone adapter (ATA), 328
- analog telephone ISP connections, 373, 377
- Android OS, 458. *See also* mobile devices
 - applications, 459-460
 - configuring email, 481
 - content sources, 459-460
 - patches, 491
 - rooting, 491
 - touch interface, 461
 - home screen*, 461-463
 - managing apps*, 463-466
 - managing folders*, 465
 - managing widgets*, 464-465
 - updates, 491
- angry customers, dealing with, 614
- ANSI (American National Standards Institute), 341
- anti-adware programs, 571
- antiphishing programs, 571
- antispware programs, 89, 571
- antistatic bags, 97
- antistatic mats, 85, 141
 - properly using, 93-98
- antistatic wrist straps, 78, 108, 141
 - properly using, 92-93
- antivirus software, 89, 547, 571
 - mobile devices, 490-491
- API (application programming interface), 183
- APM (Advanced Power Management), laptops, 408
- Apple OS X, 186
- application layer firewalls, 582
- application layer protocols, 344
- application programming interface (API), 183
- applications, 4
 - Android, managing, 463-466
 - gadgets, 231-232
 - installing, 237-239
 - iOS, managing, 468-469
 - launching, 236
 - locator, smart devices, 488-489
 - managing, 183
 - mobile devices, 459-460
 - push and pull installation*, 460
 - sideloading*, 460

- OS compatibility, 187
- properties, 229
- uninstalling, 238
- architectures**
 - CPUs, 15
 - networks
 - OSI data model*, 345-347
 - TCP/IP data model*, 343-347
 - processors, 183-184
- arrays, adding, Disk Management utility, 223
- aspect ratios, 48
- ASR (Automated System Recovery), 214
- asymmetric digital subscriber line (ADSL), 374
- asymmetric encryption, 576-577
- at command, 275
- ATA (analog telephone adapter), 328
- attacks**
 - adware, 545
 - data, 544
 - data wiping, 555
 - degaussing, 555
 - external, 544
 - grayware, 545
 - hard drive destruction, 556
 - internal, 544
 - phishing, 545-546
 - physical, 544
 - rogue antivirus, 571-572
 - rootkits, 547
 - social engineering, 554
 - spyware, 545
 - TCP/IP, 552-554
 - Trojan horses, 546
 - viruses, 546
 - worms, 546
- attributes, files**, 227-228
- ATX (Advanced Technology Extended) main power connector, 118
- audio and video editing workstations, 65-66
- audio cards, audio and video editing workstations, 66
- audio ports, 40-41, 125
- authentication, two-factor authentication, 586
- auto negotiation, NICs, 349
- auto restart function, 643
- Automated Installation Kit (AIK), 210
- Automated System Recovery (ASR), 214

- automatic rotation, mobile devices, 471
- Automatic Updates utility (Windows XP), 264
- AutoPlay, 585
- AutoRun, disabling, 585-586

B

- backlight, laptops, 406-407
- backoff algorithm, 342
- Backup Utility, 277-279
- backups**
 - data, 591-593
 - hard drives, 277-279
- bandwidth, networks, 307-308
- basic disks, 197
- basic input/output system (BIOS). *See* BIOS (basic input/output system)
- batteries**
 - laptops, 396-397
 - replacing*, 426-427
 - warnings*, 412
 - mobile devices, 455
 - proper disposal, 83
- battery latches, laptops, 398
- battery test, BIOS, 136
- beep codes, BIOS (basic input/output system), 128, 163
- Berg keyed connector, 7
- Berg power connectors, 114
 - installing, 119-120
- biometric identification devices, 43
- biometric security, 567
- BIOS (basic input/output system), 128
 - beep codes, 128, 163
 - chips, 12
 - component information items, 131
 - configuring, 129-136
 - hardware diagnostics and monitoring, 134-136
 - laptop ACPI settings, 409-410
 - passwords, 133
 - troubleshooting settings, 164
- BitLocker, 569
- black and white printers, 505
- blackouts, 80
- Blue Screen of Death (BSOD), 551, 643

Bluetooth, 304

- laptops, 413-415
- mobile devices, 477-478
- BNC connectors, 33, 332**
- Boot Manager, 219-220**
- boot order settings, BIOS, 132
- boot problems, repairing, 640
- boot process, operating systems, 214-217
- bootloaders, mobile devices, 490
- BOOTMGR (Windows Boot Manager), 216, 219-220**
- bridges, 324-325
- brightness control
 - mobile device screens, 471
 - monitors, 48
- broadband ISP connections, 373
- brownouts, 81
- BSOD (Blue Screen of Death), 551, 643**
- built-in LCDs, laptops, 403
- bus network topology, 338
- bus speeds, monitoring, 135
- business policies, following, 619-620

C

- cable cards, Home Theater Personal Computers (HTPCs), 70
- cable Internet connections, 376-378
- cable meters, 98
- cable testers, 97
- cable ties, 86
- cables, 30-31, 35, 118**
 - Cat 3, 334
 - composite, 34
 - copper, 300
 - crossover, 335
 - data, installing, 120-122
 - DVI (Digital Visual Interface) cables, 34
 - external, 31-35
 - installing, 126-127*
 - FireWire, 37-38
 - front panel, installing, 122-125
 - inspecting, 160
 - internal, 30-35
 - installing, 118-122*
 - modem, 36
 - network, 39, 300, 330-331
 - coaxial cables, 35, 332-336*
 - fiber-optic cables, 336-337*
 - parallel, 38
 - PATA, 114
 - plenum, 334
 - PS/2, 40
 - SATA, 114
 - SCSI, 38-39
 - serial, 35-36
 - USB, 36-37
 - UTP, testing, 98
- cache memory, 22
- caches, 15
- call center employee rules, following, 619
- call centers, 625-629
 - level one technician responsibilities, 626-627
 - level two technician responsibilities, 627
- call prioritization, 626
- cameras, 42
- capacitive touchscreens, 456
- capacitors, 11
- capture cards, 23
 - selecting, 57
- car speakerphones, Bluetooth, 477
- card keys, 586
- carrier sense multiple access with collision detection (CSMA/CD), 342
- cases, 4-6, 106**
 - cleaning, 98, 158-159
 - fans, 17
 - Home Theater Personal Computers (HTPCs), 69
 - installing, 126
 - opening, 106-107
 - selecting, 49-50
- Cat 3 cables, 334**
- cathode-ray tube (CRT) monitors, 45
- CAX workstations, 65**
- CCNA (Cisco Certified Network Associate), 313**
- CDFS (Compact Disc File System), 199**
- CDMA (Code Division Multiple Access), 475**
- CDs (compact discs), cleaning, 440**
- cellular communications, mobile devices, 475-477
- cellular data networks, 474
- cellular ISP connections, 375, 378
- cellular towers, 489

- cellular WAN cards, laptops, 417
- central processing units (CPUs). *See* CPUs (central processing units)
- chain of custody, 623-624
- Change Action Center settings (Action Center), 246
- Change User Account Control settings (Action Center), 246
- channels, wireless routers, 359
- charging step, laser printing, 510
- chemical solvents, proper disposal, 84
- chkdsk tool, 88, 256-258
- circuit boards, iPhones, 455
- CISC (Complex Instruction Set Computer) chips, 15
- Cisco Certified Network Associate (CCNA), 313
- cleaning
 - case, 158-159
 - internal components, 158-159
 - laptops, 439-440
 - materials, properly using, 98-100
 - printers, 530-532
 - tools, 86
- cleaning step, laser printing, 510
- CLI (command-line interface). *See* command-line interface (CLI)
- client/server networks, 306-307
- client-side virtualization, 268-271
- climate effects, computer equipment, 80
- clock speed settings, BIOS, 132
- clock speeds, monitoring, 135
- Clock widget (Android), 464
- cloning disk, 207
- closed-ended questions, 163, 611
- closed source operating systems, 458
- cloud-enabled services, mobile devices, 487
 - locator applications, 488-489
 - remote backup, 487-488
 - remote lock, 489
 - remote wipe, 489
- clusters, 198
- CMD command (Run Line), 266
- CMOS battery, installing, 139
- CMOS (complementary metal-oxide semiconductor) batteries, 129
- coaxial cables, 35, 332
 - twisted-pair, 332-336
- Code Division Multiple Access (CDMA), 475
- color printers, 505
- color resolution, monitors, 48
- command-line interface (CLI), 182, 264-265
 - commands, troubleshooting, 655-656
 - Run Line utility, 266-268
- Command Prompt option (System Recovery), 212
- commands
 - at, 275
 - fixmbr, 212
 - ipconfig, 318, 362
 - ipconfig /all, 348
 - ipconfig /renew, 355
 - net, 363
 - nslookup, 364-365
 - ping, 348, 362
 - Run Line utility, 266-268
 - tracert, 364
 - troubleshooting, 655-656
- common problems and solutions, 169, 637-639
 - CPUs, 173-174
 - laptops, 661-663
 - memory, 173-174
 - motherboards, 171-172
 - operating systems, 643-648, 652-656
 - peripherals, 637-639
 - power supplies, 172-173
 - printers, 668
 - security, 673-675
 - storage devices, 169-171
- communication encryption, 575-577
- communication skills, 608
 - determining customer problems, 610-611
 - keeping customer focused, 613-615
 - professionalism, 609
 - troubleshooting, 608-609
- Compact Disc File System (CDFS), 199
- CompactFlash cards, 61
- Compatibility Center, 188-189
- complementary metal-oxide semiconductor (CMOS), 129
- Complex Instruction Set Computer (CISC) chips, 15
- component contacts, cleaning, 99
- Component Object Model (COM) components, 254
- component retrieving tools, 96-97
- Component/RGB cables, 34
- Component Services (Administrative Tools), 254
- composite cables, 34

compressed air, 86, 99

computer cases, 4-6, 106

cleaning, 98, 158-159

fans, 17

Home Theater Personal Computers (HTPCs), 69

installing, 126

opening, 106-107

selecting, 49-50

computer components. *See also* specific components

troubleshooting, 634-640

common problems and solutions, 637-639

documentation, 637

full system functionality verification, 636

identifying problem, 634

implementing solutions, 636

testing theory, 635

theory of probable cause, 635

computer disassembly, 100

Computer Explorer, 236

computer forensics, 622, 629

Computer Management console (Administrative Tools), 252-253

computer networks. *See* networks

computer-sharing printers, 527-528

computer systems, 4. *See also* hardware; software

cases, 5-6

hardware

adapter cards, 22-23, 54-57

cases, 4-6, 49-50

central processing units (CPUs), 13-16

cooling systems, 16-18, 51-53

CPUs, 51-53

expansion slots, 23-25

external cables, 31-35

external storage, 62

floppy disk drives, 57

hard disk drives, 57-59

internal cables, 30-31, 35

I/O (input/output) devices, 41-49, 63-64

I/O (input/output) ports, 35-41

media readers, 61

memory modules, 20-22

motherboards, 11-13, 50-51

optical drives, 62

power supplies, 4-11, 49-50

RAID (redundant array of independent disks), 29-30

RAM (random-access memory), 18-20, 53

ROM (read-only memory), 18-19

solid state drive (SSD), 60

storage devices, 25-28

video ports, 32-33

power supplies, 7

specialized, 64

audio and video editing workstations, 65-66

CAX workstations, 65

gaming PCs, 68-69

Home Theater Personal Computers (HTPCs), 69-70

virtualization workstations, 67

conduits, 586

configuring

BIOS, 129-136

Bluetooth, laptops, 414-415

email, mobile devices, 481-482

email accounts, 479

firewalls, 593-595

NICs, 351-353

printers, 518-520

sharing, 523-525

connection types (ISP), selecting, 372-379

connections

problems, troubleshooting, 652-653

routers, 353-354

Connections tab (Internet Options), 242

connectivity, wireless routers, testing, 360-365

connectors, 7-8

I/O, 63

video, 32

content sources, mobile devices, 459

Content tab (Internet Options), 242

contrast control, monitors, 48

contrast ratios, 47

Control Panel

utilities, 239-244, 247

Action Center, 245-246

Device Manager, 250-251

Display Settings, 243-244

Folder Options, 245

Internet Options, 242-243

Power Options, 247-248

Regional and Language Options, 252

System, 248-250

User Accounts, 241-242
Windows Firewall, 246-247
 Windows 7, 261-262
 Windows Vista, 262-263
 Windows XP, 263-264
cooling systems, 16-18
 gaming PCs, 68
 inspecting, 159
 installing, 110-111
 selecting, 51-53
 upgrading, 141-142
copper cabling, 300
copy backups, Backup Utility, 278
costs, network cabling, 331
counterfeit components, 329
CPUs (central processing units), 12-16
 architectures, 15, 183-184
 CAx workstations, 65
 common problems and solutions, 173-174
 cooling system, inspecting, 159
 cores, 67
 dual-core, 16
 fans, 17
 gaming PC, 68
 hexa-core, 16
 hyperthreading, 15
 hypertransport, 15
 installing, 108-111, 138
 land grid array (LGA), 14
 laptops, 402
 replacing, 434-435
 octa-core, 16
 overclocking, 16
 pin grid array (PGA), 14
 quad-core, 16
 selecting, 51-53
 single-core, 16
 slot-based, 14
 thermal compound, 109
 throttling, 16, 402
 triple-core, 16
 upgrading, 141-142
crimpers, 86
cross-platform data synchronization, mobile devices, 484

crossover cables, 335
 CRT (cathode-ray tube) monitors, 45
 cleaning, 98
 CRU (customer-replaceable units), 424
 CSMA/CD (carrier sense multiple access with collision detection), 342
 current, electrical, 9, 80
 custom options, operating system installation, 207-214
 customer call rules, following, 619
 customer-replaceable units (CRU), 424
 customers
 operating system requirements, 187-189
 putting on hold, 611
 transferring calls, 612
 troubleshooting
 conversation etiquette, 162-163
 documenting responses, 163
 questions, 163
 working with, 610-616
 cyber laws, 622-623, 629
 cylinders, 198

D

data backups, 161-162, 568, 591-593
 Backup Utility, 278
data bus, 51
data cables, installing, 120-122
data encryption, 569-570
 Data Encryption Standard (DES), 575
data migration, 195-196
Data Sources (Administrative Tools), 254
data synchronization, mobile devices, 482-483
data threats, 544
data transmissions, networks, 308-309
data wiping, 555
 DB-15 connectors, 33
 DC (direct current) power, 4, 6
 DC jacks, laptops, replacing, 427-428
 DDoS (distributed DoS) attacks, 552
 DDR SDRAM (double data rate SDRAM), 20
 DDR2 SDRAM (double data rate 2 SDRAM), 20
 DDR3 SDRAM (double data rate 3 SDRAM), 20
 dedicated PC print servers, 527

- de-encapsulation, 346
- default gateways, 315
- Defrag tool, 88
- degaussing
 - hard drives, 555
 - wands, 555
- demilitarized zone (DMZ), 582-583
- denial of service (DoS) attacks, 552
- DES (Data Encryption Standard), 575
- desktop, Windows, 230-233
 - gadgets, 231-232
 - properties, 232-233
- desktop operating systems, 185
 - Apple OS X, 186
 - Linux, 186
 - Microsoft Windows, 185-186
- developing step, laser printing, 510
- device drivers, updates, 273
- Device Manager (Control Panel), 164-165, 206, 250-251
- device tracking, GPS (Global Positioning System), 472
- devices
 - I/O (input/output), 41-49
 - like, 335
 - mobile, 454, 498
 - accelerometers*, 471
 - batteries*, 455
 - cloud-enabled services*, 487-489
 - email software*, 479-482
 - factory resets*, 497
 - GPS (Global Positioning System)*, 472-473
 - memory cards*, 455
 - network connectivity*, 473-478
 - non-field-serviceable parts*, 454-455
 - non-upgradeable hardware*, 455-456
 - operating systems*, 458-470
 - screen calibration*, 471
 - screen orientation*, 470-471
 - security*, 485-491
 - SIM (Subscriber Identity Module) cards*, 455
 - solid state drives (SSD)*, 457-458
 - synchronization*, 482-484
 - touchscreens*, 456-457
 - troubleshooting*, 492-497
- DHCP (Dynamic Host Configuration Protocol), 315-317
- diagnostic tools, 86-89
- dialup networking (DUN), 323
- differential backups, Backup Utility, 278
- digital cameras, 42
- Digital Light Processing (DLP) displays, 46
- digital multimeters, 86-87
- digital signatures, 576
- digital standards, 475
- digital subscriber line (DSL) ISP connections, 373, 378
- Digital Visual Interface (DVI) connectors, 32
- Digital Visual Interface (DVI) port, docking stations, 404
- digitizers, 43-44
- DIMM (dual in-line memory module), 20
- DIP (dual in-line package) chips, 20
- direct current (DC) power, 4, 6
- directories, structures
 - drive mapping, 224
 - mounting volumes, 224-225
- DirectX, 183
- disabling
 - AutoRun, 585-586
 - devices, BIOS, 132
- disassembling computers, 100
- Disk Cleanup tool, 88
- disk cloning, 207
- Disk Defragmenter, 256-258
- Disk Error-Checking tool, 256-258
- Disk Management Tool, 88
- Disk Management utility, 220-221
 - adding arrays, 223
 - adding drives, 222
 - assigning drive letters, 222
 - drive status, 221
 - extending partitions, 222
 - splitting partitions, 222
- Display Settings utility (Control Panel), 243-244
- Displayport, 32
- displays, 44-46
 - audio and video editing workstations, 66
 - characteristics, 46-48
 - cleaning, 98
 - connecting multiple, 48-49
 - interlaced, 48

- laptops, 405-406
 - LED*, 396, 400, 406
 - OLED*, 406
 - plasma*, 406
 - power management*, 411-412
 - replacing*, 430-431
- proper disposal, 84
- distributed DoS (DDoS) attacks, 552
- DLP (Digital Light Processing) displays, 46
- DMZ (demilitarized zone), 582-583
- DNS poisoning attacks, 553
- DNS servers, 317
- docking station connectors, laptops, 398
- docking stations, 403-404
 - rear view, 405
 - right-side view, 405
- documentation, 624
 - customer responses, 163
 - troubleshooting, 168-169
- domain controllers, 366
- domains, 365
 - connecting to, 366
- DoS (denial of service) attacks, 552
- dot pitch, 47
- dots per inch (dpi), printers, 505
- double data rate 2 SDRAM (DDR2 SDRAM), 20
- double data rate 3 SDRAM (DDR3 SDRAM), 20
- double data rate SDRAM (DDR SDRAM), 20
- double touch, touchscreens, 456
- downloading, 374
- dpi (dots per inch), printers, 505
- DRAM (dynamic RAM), 19
- drive bay status indicator, laptops, 398
- drive encryption, 133
- drive letters, assigning, Disk Management utility, 222
- drive mapping networks, 370-371
- drive status, Disk Management utility, 221
- drivers
 - printers, 514-515
 - installing*, 515-518
 - optimization*, 521
 - signed, 148
- drives
 - adding, Disk Management utility, 222
 - floppy disk, installing, 114-115

- hard disk
 - installing*, 113
 - upgrading*, 144-145
- mapping, 224
- optical, installing, 113-114
- RAID, upgrading, 145-146
- DSL (digital subscriber line) ISP connections, 373, 378
- dual-core CPUs, 16
- dual in-line memory module (DIMM), 20
- dual in-line package (DIP) chips, 20
- DUN (dialup networking), 323
- duplex and speed settings, NICs, 352
- DVDs, cleaning, 440
- DVI (Digital Visual Interface) cables, 34
- DVI (Digital Visual Interface) connectors, 32
- DVI (Digital Visual Interface) port, docking stations, 404
- DXDIAG command (Run Line), 266
- dynamic disks, 197
- Dynamic Host Configuration Protocol (DHCP), 315-317
- dynamic RAM (DRAM), 19

E

- E2500 management, 580
- EAP (Extensible Authentication Protocol), 579
- ECC (error-correcting code) memory, 22
- EDGE (Enhanced Data Rates for GSM Evolution), 375, 475
- EDO (Extended Data Out) RAM, 19
- EEPROM (electrically erasable programmable read-only memory), 19
- EFS (Encrypting File System), 569-570
- EIDE (Enhanced Integrated Drive Electronics) interface, 28
- EISA (Extended ISA) expansion slots, 24
- electrical safety guidelines, 78
- electrically erasable programmable read-only memory (EPROM), 19
- electricity
 - current, 6
 - Ohm's law, 9-11
 - units, 8

electromagnetic interference (EMI), 80

electrostatic discharge (ESD), 79, 107

email

accounts, configuring, 479

safe attachments, 547

spam, 551-552

troubleshooting failures, 654

email protocols, 479

IMAP (Internet Message Access Protocol), 480

MIME (Multipurpose Internet Mail Extension), 480

POP3 (Post Office Protocol Version 3), 479-480

SMTP (Simple Mail Transport Protocol), 480

SSL (Secure Sockets Layer), 480

email software, mobile devices, 479-481

configuring, 481-482

EMI (electromagnetic interference), 80

employee access, terminating, 595

encapsulation, 346

encoding hash, 575

Encrypting File System (EFS), 569-570

encryption, 569-570

Advanced Encryption Standard (AES), 579

asymmetric, 576-577

communication, 575-577

Data Encryption Standard (DES), 575

private key, 576

public key, 576

symmetric, 575-576

Triple Data Encryption Standard (3DES), 575

Enhanced Data Rates for GSM Evolution (EDGE), 375, 475

Enhanced Integrated Drive Electronics (EIDE)

interface, 28

environments

OS compatibility, 187

protecting, 82-84

EPROM (erasable programmable read-only memory), 19

equipment disposal, 83-84

erasable programmable read-only memory (EPROM), 19

ergonomic input devices, 147

error checking memory, 22

error-correcting code (ECC) memory, 22

eSATA (External Serial ATA) data cable, 38

eSATA (External Serial ATA) interface, 28

ESD (electrostatic discharge), 79, 107

ESD tools, 85

Ethernet

cables, 35

connections, printers, 507, 513

ports

docking stations, 404

laptops, 397

protocols, 342

settings

laptops, 418

standards

networks, 341-343

ethical considerations in IT, 620-621

EV-DO (Evolution-Data Optimized), 375, 476

Event Viewer (Administrative Tools), 164, 253

Evolution-Data Optimized (EV-DO), 375, 476

exceptions, 566

Exchange mail server, 480

exFAT (FAT 64), 199

exhaust vent, docking stations, 404

expansion cards, laptops, 419-421

expansion slots, 23, 25

EXPLORER command (Run Line), 266

exposing step, laser printing, 510

ExpressCard slots, laptops, 396

Extended Data Out (EDO) RAM, 19

Extended ISA expansion slots, 24

extended partitions, 197

extended star network topology, 339

extending partitions, Disk Management utility, 222

Extensible Authentication Protocol (EAP), 579

extensions, files, 227-228

external cables, 31-35

external diskette drive connector, docking station, 404

external flash drives, 28

laptops, 421

external hard drive enclosures, 87

external storage, selecting, 62

external threats, 544

F

F series connections, 332

Facebook widget (Android), 465

factory recovery partition, 214

- ul style="list-style-type: none;">
- factory resets, mobile devices, 497
- failed login attempt restrictions, mobile devices, 486-487
- fan assemblies, 109
 - installing, 110-111
 - selecting, 51-53
 - upgrading, 141-142
- fan speeds, monitoring, 135
- Fast Page Mode (FPM), 19
- FAT32 (File Allocation Table, 32-bit) file system, 198
 - versus NTFS, 564
- FDD (floppy disk drive), 26
 - data cable, 31
 - installing, 114-115
 - selecting, 57
- FDISK tool, 88
- fiber broadband ISP connections, 376
- fiber-optic cables, 336-337
- fiber-optic cabling, 300
- field-replaceable units (FRUs), 10, 425
- field-serviceable parts, 454
- file allocation units, 198
- File and Settings Transfer Wizard for Windows XP, 196
- file sharing, networks, 369-370
- file systems, 198-199, 564
 - Encrypting File System (EFS), 569-570
 - FAT32 (File Allocation Table, 32-bit) file system, 198
 - versus NTFS*, 564
 - Infected, remediation, 572-573
 - NTFS (New Technology File System), 198
- File Transport Protocol (FTP)
 - troubleshooting, 654-655
- files, 182
 - attributes, 227-228
 - BOOTMGR, 219-220
 - extensions, 227-228
 - locations, 225-227
 - opening, 236
 - permissions, 561-564
 - principle of least privilege*, 564
 - restricting*, 565
 - properties, 229
 - Registry, 217-218
 - signature, updates, 573-574
- filtering
 - ActiveX, 548
 - MAC addresses, 578
- fire safety guidelines, 78-79
- firewalls
 - configuring, 593-595
 - hardware, 328-329, 581-582
 - port forwarding, 583-584
 - port triggering, 584
 - software, 565-567
 - troubleshooting, 675
- FireWire connections, printers, 507
- FireWire ports, 37-38
- firmware, 19
 - updates, 274
- firmware, printers, 521
- first generation (1G) cell phones, 475
- first response, 623
- fixboot command, 212
- fixmbr command, 212
- Flash (Adobe), 548
- flash card readers, laptops, 421-422
- flash cards, laptops, 421-422
- flash drives, 28
 - laptops, 421
- flash memory storage, mobile devices, 457
- flashlights, 86
- flat-head screwdrivers, 85, 95
- flat-head screws, replacing with Phillips-head screw, 140
- floppy data cables, installing, 121-122
- floppy disk drive (FDD) data cable, 31
- floppy disk drives, 26
 - installing, 114-115
 - selecting, 57
- Fn (Function) key, laptops, 402-403
- Folder Options utility (Control Panel), 245
- folders, 182, 225-227
 - Android, managing, 465
 - Fonts, 225-226
 - iOS, managing, 469-470
 - permissions, 561-564
 - principle of least privilege*, 564
 - restricting*, 565

- Program Files, 227
- properties, 229
- System, 225
- Temporary Files, 226-227
- FOMA (Freedom of Mobile Multimedia Access), 476
- Fonts folder, 225-226
- Foreign drive status (Disk Management), 221
- form factors, 5
 - motherboards, 12
 - laptops*, 401
- formatting hard disk drives, 197-200
- Format tool, 88
- fourth-generation (4G) digital standards, 476
- FPM (Fast Page Mode), 19
- frames, 307, 324
- Freedom of Mobile Multimedia Access (FOMA), 476
- frequencies, buses, 52
- front side bus (FSB), 15, 52
- FRU (field-replaceable units), 10, 425
- FSB (front side bus), 15, 52
- FTP (File Transport Protocol), troubleshooting, 654-655
- full duplex data transmissions, 309
- full format, versus quick format, 200
- full user access (BIOS), 133
- Function (Fn) key, laptops, 402-403
- fusing step, laser printing, 510

G

- Gadget Gallery, 231
- gadgets, 231-232
- gamepads, 42
- Gameport/MIDI port, 40
- gaming PCs, 68-69
- General Packet Radio Service (GPRS) cellular WANs, 375, 475
- General tab (Folder Options), 245
- General tab (Internet Options), 242
- geocaching, GPS (Global Positioning System), 472
- geotagging, GPS (Global Positioning System), 472
- gestures, touchscreens, 456
- global method, printer configuration, 520
- Global Positioning System (GPS), 489
 - mobile devices, 472-473
- Global System for Mobile Communications (GSM)
 - cellular WANs, 375, 475
- Google search app, Android OS home screen, 462
- GPRS (General Packet Radio Service) cellular WANs, 375, 475
- GPS (Global Positioning System), 489
 - mobile devices, 472-473
- graphical user interface (GUI), 182-183
 - Windows, 230-239
- graphics cards
 - cooling system, 18
 - selecting, 54-55
- grayware, 545
- GSM (Global System for Mobile Communications)
 - cellular WANs, 375, 475
- guest accounts, 595
- GUI (graphical user interface), 182-183
 - Windows, 230-239

H

- half duplex data transmissions, 309
- hand tools, 85
 - properly using, 94
- handsfree headsets, Bluetooth, 477
- hard disk drives, 26
 - assigning drive letters, Disk Management utility, 222
 - audio and video editing workstations, 66
 - backups, 277-279
 - data wiping, 555
 - degaussing, 555
 - destruction, 556
 - drive status, Disk Management utility, 221
 - formatting, 198-200
 - Home Theater Personal Computers (HTPCs), 70
 - installing, 113
 - interfaces, 28
 - laptops
 - power management*, 411-412
 - replacing*, 431-432
 - maintenance tools, 256
 - mapping, 224
 - partitioning, 196-198
 - partitions
 - active*, 197
 - basic disks*, 197

- dynamic disks*, 197
- extended*, 197
- extending*, 222
- formatting*, 197
- logical drives*, 197
- primary*, 197
- splitting*, 222
- recycling, 556
- selecting, 57-59
- testing, BIOS, 136
- upgrading, 144-145
- hard drive access panel, laptops**, 398
- hardware**, 4. *See also* specific hardware
 - accessing, operating systems, 182
 - adapter cards, 22-23
 - selecting*, 54-57
 - analog telephone adapter (ATA), 328
 - Berg power connector, 114
 - BIOS hardware diagnostics and monitoring, 134-136
 - bridges, 324-325
 - cases, 4-6, 106
 - installing*, 126
 - opening*, 106-107
 - selecting*, 49-50
 - central processing units (CPUs), 13-16
 - cooling systems, 16-18
 - installing*, 110-111
 - selecting*, 51-53
 - upgrading*, 141-142
 - CPUs (central processing units)
 - common problems and solutions*, 173-174
 - installing*, 108-111
 - selecting*, 51-53
 - thermal compound*, 109
 - upgrading*, 141-142
 - expansion slots, 23-25
 - external cables, 31-35
 - installing*, 126-127
 - external storage, selecting, 62
 - firewalls, 328-329
 - floppy disk drives
 - installing*, 114-115
 - selecting*, 57
 - front panel cables, installing, 122-125
 - hard disk drives
 - installing*, 113
 - partitioning*, 196-198
 - selecting*, 57-59
 - upgrading*, 144-145
 - HCL (hardware compatibility lists), 192
 - hubs, 323
 - internal cables, 30-31, 35
 - internal data cables, installing, 120-122
 - internal power cables, installing, 118-120
 - Internet appliances, 329
 - I/O (input/output) devices, 41-49
 - selecting*, 63-64
 - upgrading*, 147-148
 - I/O (input/output) ports, 35-41
 - IP phones, 328
 - media readers, selecting, 61
 - memory, common problems and solutions, 173-174
 - memory modules, 20-22
 - modems, 322-323
 - motherboards, 11-13, 137
 - common problems and solutions*, 171-172
 - component upgrades*, 137-139
 - installing*, 108-112
 - selecting*, 50-51
 - upgrading*, 139-144
 - network-attached storage (NAS), 327
 - NICs, installing, 116
 - optical drives
 - installing*, 113-114
 - selecting*, 62
 - OS requirements, 188-189
 - POST cards, 129
 - power protection devices, 81
 - power supplies, 4-7
 - capacitors*, 11
 - common problems and solutions*, 172-173
 - connectors*, 7-8
 - installing*, 107-108
 - Ohm's law*, 9-11
 - selecting*, 49-50
 - units of electricity*, 6-8
 - preventive maintenance tasks, 157
 - print servers, 526-528
 - printers, 504, 537
 - black and white*, 505
 - capabilities*, 505
 - color*, 505
 - common features*, 504
 - configuring*, 518-520

- control panel*, 518
- dots per inch (dpi)*, 505
- drivers*, 514-518
- impact*, 511-512
- inkjet*, 508
- installing*, 513-514
- laser*, 509-511
- optimizing performance*, 520-522
- pages per minute (ppm)*, 505
- preventive maintenance*, 528-532
- printing test pages*, 516-518
- quality*, 505
- reliability*, 505
- sharing*, 523-526
- speed*, 505
- testing*, 516-518
- thermal*, 511
- total cost of ownership (TCO)*, 506
- troubleshooting*, 532-536
- wired connection types*, 506-507
- RAID, 29-30
 - upgrading*, 145-146
- RAM (random-access memory), 18-20
 - installing*, 111
 - selecting*, 53
 - upgrading*, 142-143
- ROM (read-only memory), 18-19
- routers, 325-326, 353-354
- solid state drives, selecting, 60
- storage devices, 25-28
 - common problems and solutions*, 169-171
- switches, 324-325
- video adapter cards, installing, 117-118
- video ports, 32-33
- Voice over IP (VoIP) phones, 327-328
- wireless NICs, installing, 116-117
- hardware firewalls, 581-582
- hardware tools, 84-87
- hash encoding, 575
- HCL (hardware compatibility lists), 192
- HDD (hard disk drive). *See* hard disk drives
- HDMI (High-Definition Multimedia Interface)
 - cables, 34
- HDMI output, Home Theater Personal Computers (HTPCs), 69
- headphone connector, docking stations, 404
- headphones, 46
- Healthy drive status (Disk Management), 221
- heat sinks, 17, 109
 - installing*, 110-111
 - selecting*, 51-53
 - upgrading*, 141-142
- help desk software, 625
- HEPA (High Efficiency Particulate Air)
 - filtration*, 531
- hex drivers, 86, 95-96
- hexa-core CPUs, 16
- hexadecimal values, 310
- Hibernate mode, laptops, 410-411
- hierarchical network topology, 339
- High-Definition Multimedia Interface (HDMI)
 - cables, 34
- High Efficiency Particulate Air (HEPA)
 - filtration*, 531
- high-level formats, hard drives, 556
- High-Speed Downlink Packet Access (HSDPA), 375
- Home button (iOS), 467
- home networks, 355
- home screen
 - Android OS, 461-463
 - managing apps*, 463-466
 - managing folders*, 465
 - managing widgets*, 464-465
 - iOS, 466-468
 - managing apps*, 468-469
 - managing folders*, 469-470
- Home Theater Personal Computers (HTPCs), 69-70
- HomeGroup, 261
- homegroup, Windows 7, 366-368
- horizontal resolution, monitors, 48
- hosts, 300
- hot-swappable eSATA drives, 59
- HP Printer Command Language (PCL), 510
- HSDPA (High-Speed Downlink Packet Access), 375
- HTPCs (Home Theater Personal Computers), 69-70
- hubs, 323
- hybrid network topology, 339
- hyperthreading, CPUs, 15
- hypertransport, CPUs, 15
- hypervisor, 269-270

- I**
- IAB (Internet Architecture Board), 341
 - iCloud, 481
 - ICMP (Internet Control Message Protocol), 317-319
 - IDE (Integrated Drive Electronics) interface, 28
 - iDEN (Integrated Digital Enhanced Network), 475
 - IEC (International Electrotechnical Commission), 341
 - IEEE (Institute of Electrical and Electronics Engineering), 341-342, 507
 - image-based operating system installations, 208-210
 - IMAP (Internet Message Access Protocol), 480
 - impact printers, 511-512
 - incremental backups, Backup Utility, 278
 - Industry Standard Architecture (ISA) expansion slots, 24
 - inexperienced customers, dealing with, 615
 - Infrared (IR) wireless technology, laptops, 415-416
 - infrared ports, laptops, 397
 - Initializing drive status (Disk Management), 221
 - inkjet printers, 508
 - InPrivate browsing, 550-551
 - input devices, 41
 - biometric identification devices, 43
 - digital cameras and video cameras, 42
 - digitizers, 43-44
 - gamepads, 42
 - joysticks, 42
 - keyboards, 41-42
 - laptops, 399-400
 - mouse, 41-42
 - scanners, 44
 - touchscreens, 43
 - input/output (I/O) devices, 41-49
 - selecting, 63-64
 - input/output (I/O) ports, 35-41
 - inspecting internal components, 159-160
 - installing
 - applications, 237-239
 - push and pull*, 460
 - sideloading*, 460
 - Bluetooth, laptops, 414-415
 - cables
 - external*, 126-127
 - front panel*, 122-125
 - internal data*, 120-122
 - internal power*, 118-120
 - cases, 126
 - CMOS battery, 139
 - cooling systems, 110-111
 - CPUs, 108-111, 138
 - floppy disk drives, 114-115
 - hard disk drives, 113
 - motherboards, 108-112
 - networks, completion lists, 347-348
 - NICs, 116, 350-351
 - operating systems, 196
 - account creation*, 203-204
 - completing*, 204-206
 - custom options*, 207-214
 - default settings*, 200-202
 - hard drive formatting*, 198-200
 - hard drive partitioning*, 196-198
 - system recovery options*, 211-214
 - optical drives, 113-114
 - power supplies, 107-108
 - printer drivers, 515-518
 - printers, 513-514
 - RAM, 111
 - video adapter cards, 117-118
 - wireless NICs, 116-117
 - Integrated Digital Enhanced Network (iDEN), 475
 - Integrated Drive Electronics (IDE) interface, 28
 - Integrated Services Digital Network (ISDN), 373, 378
 - interfaces
 - Android OS, 461
 - home screen*, 461-463
 - managing apps*, 463-466
 - managing folders*, 465
 - managing widgets*, 464-465
 - hard drives, 28
 - iOS
 - home screen*, 466-468
 - managing apps*, 468-469
 - managing folders*, 469-470
 - interlaced monitors, 48
 - internal cables, 30-31, 35
 - internal threats, 544
 - International Electrotechnical Commission (IEC), 341

International Organization for Standardization (IOS), 341

Internet appliances, 329

Internet Architecture Board (IAB), 341

Internet Control Message Protocol (ICMP), 317-319

Internet layer protocols, 344

Internet Message Access Protocol (IMAP), 480

Internet Options utility (Control Panel), 242-243

Internet reference tools, 90

Internet service provider (ISP), 325

intrusion detection, BIOS, 136

inverters, laptops, 406-407

I/O (input/output) cards, selecting, 56

I/O (input/output) connector plate, 112

I/O (input/output) devices, 41-49

- selecting, 63-64
- upgrading, 147-148

I/O (input/output) ports, 35-41

iOS, 458. *See also* mobile devices

- applications, 459-460
- configuring email, 481-482
- content sources, 459-460
- jailbreaking, 491
- patches, 491
- touch interface
 - home screen*, 466-468
 - managing apps*, 468-469
 - managing folders*, 469-470
- updates, 491

IOS (International Organization for Standardization), 341

IP addressing, 309-310

- static, 314-315

IP phones, 328

ipconfig command, 318, 362

ipconfig /all command, 348

ipconfig /renew command, 355

iPhones, circuit boards, 455

IPv4 addressing, 310-311

- subnet masks, 312-313

IPv6 addressing, 310, 313-314

IR (Infrared) wireless technology, laptops, 415-416

ISA (Industry Standard Architecture) expansion slots, 24

ISDN (Integrated Services Digital Network), 373, 378

ISPs (Internet service providers), 325

- selecting connection types, 372-379
- selecting for customers, 376-379

IT Essentials: PC Hardware and Software Lab Manual, 11, 70

iTunes, 468

ITU-T standards organization, 341

J

jailbreaking, iOS, 491

Java, 548

- APIs (application programming interfaces), 183

JavaScript, 548

joysticks, 42

jumpers, motherboards, settings, 138-139

K

key fobs, 568

keyboard port, docking station, 404

keyboard, video, mouse (KVM) switch, 42

keyboards, 41-42

- Bluetooth, 477
- cleaning, 99, 160
- laptops
 - cleaning*, 439
 - removing*, 425
 - replacing*, 428-429

keyed connectors, 7-8

keyloggers, 571

keys, Registry, 217

knowledgeable customers, dealing with, 614

KVM (keyboard, video, mouse) switch, 42

L

laboratories

- data protection, 79-81
- proper tool usage, 84
 - antistatic mats*, 93-98
 - antistatic wrist straps*, 92-93
 - cleaning materials*, 98-100

- hand tools*, 94
- hardware tools*, 84-87
- organizational tools*, 89-91
- software tools*, 88-89
- protecting environment, 82-84
- protecting equipment, 79-81
- safe procedures, 77-79
- land grid array (LGA) CPUs**, 14
- LANs (local area networks)**, 302-303
 - architecture, 339
- laptops**, 395, 399-400, 447
 - AC power adapters, 396
 - backlight, 406-407
 - batteries, 396-397
 - replacing*, 426-427
 - battery latches, 398
 - bottom view, 399
 - CPUs, 402
 - replacing*, 434-435
 - customer-replaceable units (CRU), 424
 - DC jacks, replacing, 427-428
 - displays, 405-406
 - replacing*, 430-431
 - docking stations, 403-405
 - connectors*, 398
 - drive bay status indicator, 398
 - Ethernet port, 397
 - expansion cards, 419-421
 - ExpressCard slots, 396
 - external features, 395-399
 - external flash drives, 421
 - field-replaceable units (FRU), 425
 - flash card readers, 421-422
 - flash cards, 421-422
 - front view, 398
 - hard drive access panel, 398
 - hard drives, replacing, 431-432
 - infrared ports, 397
 - input devices, 399-400
 - inverters, 406-407
 - keyboards
 - removing*, 425
 - replacing*, 428-429
 - latches, 398
 - LCDs, built-in, 403
 - LED displays, 396, 400
 - left-side view, 397
 - microphone jacks, 397
 - modem port, 397
 - motherboards, 401
 - network LEDs, 397
 - optical drive status indicator, 398
 - optical drives, 398
 - replacing*, 432
 - PC cards, 396
 - PC combo expansion slot, 397
 - plastics, replacing, 436-437
 - port replicators, 403-404
 - power management, 408
 - ACPI*, 409-410
 - Power Options utility*, 410-412
 - preventive maintenance, 437
 - cleaning procedures*, 439-440
 - scheduling maintenance*, 437-438
 - RAM, 401-402
 - access panel*, 398
 - rear view, 396
 - right-side views, 398
 - security keyhole, 397
 - SODIMM memory, 422-424
 - speakers, 398
 - replacing*, 433
 - special function keys, 402-403
 - stereo headphone jack, 397
 - S-Video connectors, 397
 - system boards, replacing, 436
 - touchpads, replacing, 429-430
 - troubleshooting, 441, 658, 664
 - common problems and solutions*, 443-446, 661-663
 - documentation*, 443, 660
 - full system functionality verification*, 443, 660
 - identifying problem*, 441, 658
 - implementing solution*, 442, 659
 - testing theory*, 442, 659
 - theory of probable cause*, 441, 658
 - USB ports, 397
 - ventilation, 397
 - Video Graphics Array (VGA) port, 398
 - warranties, 426
 - Wi-Fi antennas, 407
 - wireless cards, replacing, 433

- wireless communication, 413
 - Bluetooth*, 413-415
 - cellular WAN cards*, 417
 - IR (Infrared)*, 415-416
 - wireless adapters*, 417-419
- laser printers, 509
 - printing process, 509-511
- Last Call widget (Android), 465
- Last Known Good Configuration startup mode, 217
- latches, laptops, 398
- LC fiber-optic connectors, 337
- LCD cutoff switches, laptops, 406
- LCDs (liquid crystal displays), 45
 - cleaning, 98
 - laptops
 - built-in*, 403
 - cleaning*, 440
- LED (light-emitting diode) displays, 45, 353
 - laptops, 396, 400, 406
- legal considerations in IT, 621
- level one technicians, 625
- level two technicians, 625
- LGA (land grid array) CPUs, 14
- LGA sockets, 141
- libraries, Windows 7, 237
- LIF sockets, 141
- light-emitting diode (LED) displays, 45
- like devices, 335
- limited user access (BIOS), 133
- line In connector, docking stations, 404
- line-in port, 40
- line of sight IR networks, 415
- line-of-sight wireless Internet connections, 374
- line-out port, 40
- link lights, 353
- Linux operating system, 186
- liquid crystal displays (LCDs). *See* LCDs (liquid crystal displays)
- lithium-ion (Li-Ion) batteries, 396
- lithium-polymer (Li-Poly) batteries, 397
- local area networks (LANs), 302-303
- location
 - files, 225-227
 - networks, setting, 354-355
- locator applications, smart devices, 488-489
- logical drives, 197

- logical network topologies, 337-340
- LoJack, 134
- Long Term Evolution (LTE), 476
- long touches, touchscreens, 456
- lookback adapters, 87
- loopback plugs, 97-98
- low-level formats, hard drives, 556
- low power warnings, laptops, 412
- LTE (Long Term Evolution), 476

M

- MAC (Media Access Control) address, 310, 315
 - filtering, 578
- magnetized tools, 96
- main distribution facility (MDF), 334
- maintenance
 - security, 589
 - configuring firewalls*, 593-595
 - data backups*, 591-593
 - maintaining accounts*, 595-596
 - operating system patches*, 589-590
 - operating system service packs*, 589-590
 - troubleshooting, 596
- malicious software protection programs, 571-573
- malware, security settings, troubleshooting, 673
- man-in-the-middle attacks, 553
- MANs (metropolitan area networks), 304
- MAPI (Messaging Application Programming Interface), 480
- mapping drives, 224
- Material Safety and Data Sheet (MSDS), 82-83
- MCA (Microchannel Architecture) expansion slots, 25
- MD5 (message digest 5), 575
- MDF (main distribution facility), 334
- mean time between failures (MTBF), printers, 505
- Media Access Control (MAC) address, 310
- media readers, selecting, 61
- memory
 - common problems and solutions, 173-174
 - memory modules, 20-22
 - nonparity, 22
 - nonvolatile, 130
 - parity, 22

- printers, 521-522
- RAM (random-access memory), 18-20, 53
 - installing*, 111
 - laptops*, 401-402
 - upgrading*, 142-143
- ROM (read-only memory), 18-19
- testing, BIOS, 136
- memory cards, mobile devices, 455
- memory modules, 20-22
- Memory Stick cards, 61
- mesh network topology, 339
- message digest 5 (MD5), 575
- message digests, 575
- Messaging Application Programming Interface (MAPI), 480
- metropolitan area networks (MANs), 304
- Microchannel Architecture (MCA) expansion
 - slots, 25
- microphone jacks, laptops, 397
- microphone port, 40
- microSD cards, 61
- Microsoft Compatibility Center, 188-189
- Microsoft Exchange mail server, 480
- Microsoft Silverlight, 548
- Microsoft Windows, upgrading, 193-195
- Microsoft Windows operating systems, 185-186
- MIME (Multipurpose Internet Mail Extension), 480
- MIMO (multiple-input and multiple-output), 374
- Mini App Tray, Android OS, 462
- mini-PCI cards, laptops, 417
- Mini-PCI expansion slots, 25
- mini-PCIe cards, laptops, 418
- MiniHDMI connectors, 34
- mirrored sites, 574
- Missing drive status (Disk Management), 221
- MMC command (Run Line), 266
- MMS (Multimedia Messaging Service), 375, 476
- mobile devices, 454, 498
 - accelerometers, 471
 - Airplane Mode, 476
 - applications
 - push and pull installation*, 460
 - sideloading*, 460
 - batteries, 455
 - bootloaders, 490
 - cloud-enabled services, 487
 - locator applications*, 488-489
 - remote backup*, 487-488
 - remote lock*, 489
 - remote wipe*, 489
 - content sources, 459
 - email software, 479-482
 - configuring*, 481-482
 - factory resets, 497
 - flash memory storage, 457
 - GPS (Global Positioning System), 472-473
 - memory cards, 455
 - network connectivity, 473
 - Bluetooth*, 477
 - Bluetooth pairing*, 477-478
 - cellular communications*, 475-477
 - wireless data network*, 473-474
 - non-field-serviceable parts, 454-455
 - non-upgradeable hardware, 455-456
 - operating systems, 458-460
 - Android*, 461-470
 - screen calibration, 471
 - screen orientation, 470-471
 - security, 485
 - antivirus software*, 490-491
 - failed login attempt restrictions*, 486-487
 - password locks*, 485-486
 - paths and updates*, 491
 - SIM (Subscriber Identity Module) cards, 455
 - solid state drives (SSD), 457-458
 - synchronization, 482-484
 - tethering, 477
 - touchscreens, 456-457
 - troubleshooting
 - common problems and solutions*, 495-497
 - documentation*, 494
 - full system functionality verification*, 494
 - identifying problem*, 492
 - resolving problem*, 494
 - testing theory*, 493
 - theory of probable cause*, 493
- Mobile WiMAX, 476
- modem adapters, 23
- modem ports, 36
 - docking stations, 404
- modem ports, laptops, 397

- modems, 322-323
- Molex keyed connector, 7
- Molex power connectors, 119
 - installing, 119-120
- monitors, 44-46
 - audio and video editing workstations, 66
 - characteristics, 46-48
 - cleaning, 98
 - connecting multiple, 48-49
 - laptops, 405-406
 - LED, 396, 400, 406
 - OLED, 406
 - plasma, 406
 - power management, 411-412
 - replacing, 430-431
 - proper disposal, 84
- motherboards, 6, 11-13, 137
 - common problems and solutions, 171-172
 - component upgrades, 137-139
 - form factors, 12
 - installing, 108-112
 - installing power connections, 118-119
 - jumpers, setting, 138-139
 - laptops, 401
 - selecting, 50-51
 - upgrading, 139-144
- Motocast USB, 483
- mounting volumes, 224-225
- mouse, 41-42
 - Bluetooth, 477
 - cleaning, 99, 160
- mouse port, docking stations, 404
- MSCONFIG command (Run Line), 266-268
- MSDS (Material Safety and Data Sheet), 82-83
- MSINFO32 command (Run Line), 267
- MSTSC command (Run Line), 267
- MTBF (mean time between failures), printers, 505
- multiboot procedures, operating systems, 218-223
- Multimedia Message Service (MMS), 375, 476
- multimeters, 86-87, 97
- multimode fiber-optic cable, 337
- multiple-input and multiple-output (MIMO), 374
- multiport bridges, 324
- multiprocessing, 181
- multipurpose devices, 326-327
- Multipurpose Internet Mail Extension (MIME), 480

- multitasking, 181
- multitasking bar (iOS), 469
- multithreading, 181
- multi-touch touchscreens, 456
- multiuser operating systems, 181

N

- NAS (network-attached storage), 327
- NAT (Network Address Translation), 357
- native resolution, monitors, 48
- navigation, GPS (Global Positioning System), 472
- navigation icons, Android OS home screen, 461-463
- needle-nose pliers, 86
- net commands, 363
- netiquette, 615-616, 628
- network access layer protocols, 345
- Network Address Translation (NAT), 357
- network-attached storage (NAS), 327
- Network Connections utility (Windows XP), 264
- network connectivity, mobile devices, 473
 - Bluetooth pairing, 477-478
 - cellular communications, 475-477
 - wireless data network, 473-474
- network devices, purchasing authentic, 329-330
- network interface cards (NICs), 23
 - selecting, 56
- network LEDs, laptops, 397
- network mode, routers, 358
- network operating system installation, 208-209
- network operating systems (NOS), 185-187
- network ports, 39
- Network Setup Wizard utility (Windows XP), 264
- networks, 299-302, 385-386
 - bandwidth, 307-308
 - benefits, 301-302
 - bridges, 324-325
 - cabling, 300, 330-331
 - coaxial cables, 332-336
 - fiber-optic cables, 336-337
 - cellular data, 474
 - client/server networks, 306-307
 - common problems and solutions, 383-384
 - computer-to-network connections, 347-353
 - data transmissions, 308-309

- device access, 580
- dialup networking (DUN), 323
- discovery, 355
- drive mapping, 370-371
- Dynamic Host Configuration Protocol (DHCP), 315-317
- Ethernet standards, 341-343
- file sharing, 369-370
- hardware firewalls, 328-329
- home, 355
- hosts, 300
- hubs, 323
- installation completion lists, 347-348
- Internet appliances, 329
- Internet Control Message Protocol (ICMP), 317-319
- IP addressing, 309-310
- IPv4 addressing, 310-311
 - subnet masks*, 312-313
- IPv6 addressing, 310, 313-314
- ISP connection types, selecting, 372-379
- ISPs (Internet service providers), selecting for customers, 376-379
- LANs (local area networks), 302-303
- location profile, 354-355
- MANs (metropolitan area networks), 304
- modems, 322-323
- multipurpose devices, 326-327
- network-attached storage (NAS), 327
- operating systems, configuring, 365-372
- OSI data model, 345-347
- PANs (personal area networks), 304
- peer-to-peer networks, 305-306
- ports, 320
- preventative maintenance, 379-380
- public, 355
- purchasing authentic devices, 329-330
- routers, 325-326
 - basic network setup*, 356-357
 - basic wireless setup*, 358-360
 - connecting to*, 353-354
 - logging in to*, 356
 - testing connectivity*, 360-365
- setting location, 354-355
- shared resources, 301
- static addressing, 314-315
- switches, 324-325
- TCP/IP data model, 343-347
- topologies, 337
 - determining*, 340-341
 - logical*, 337-340
 - physical*, 337-340
- transmission control protocol (TCP), 319-322
- troubleshooting, 380-382
 - CLI commands*, 655-656
 - connection problems*, 652-653
 - email failure*, 654
 - FTP (File Transfer Protocol)*, 654-655
 - full system functionality verification*, 382
 - identifying problem*, 380
 - resolving problem*, 381
 - secure Internet connections*, 654-655
 - testing theory*, 381
 - theory of probable cause*, 381
- user datagram protocol (UDP), 319-322
- virtual private networks (VPNs), 371-372
- Voice over IP (VoIP) phones, 327-328
- WANs (wide area networks), 304-305
- wireless access points, 325-326
- WLANs (wireless local area networks), 303
- work, 355
- New Technology File System (NTFS)**, 198
- nickel-cadmium (NiCd) batteries**, 396
- nickel-metal hydride (NiMH) batteries**, 396
- NICs (network interface cards)**, 23
 - advanced settings, 352-353
 - auto negotiation, 349
 - configuring, 351-352
 - installing, 116, 350-351
 - selecting, 56, 348-349
 - updating, 350-351
- no user access (BIOS)**, 133
- noise interference, power**, 81
- noninterlaced monitors**, 48
- nonparity memory**, 22
- nonvolatile memory**, 130
- normal backups, Backup Utility**, 278
- Northbridge controls**, 13
- NOS (network operating systems)**, 185-187
- Not Initialized drive status (Disk Management)**, 221
- NOTEPAD command (Run Line)**, 267
- Notes widget (Android)**, 464
- notification center (iOS)**, 467-468

nslookup command, 364-365

NT kernel, 216

NTFS (New Technology File System), 198

versus FAT32, 564

NTLDR (NT loader), 216

O

Occupational Safety and Health Administration (OSHA), 82

octa-core CPUs, 16

ODBC (Open Database Connectivity), 254

Offline drive status (Disk Management), 221

Offline Files utility (Windows Vista), 263

Ohm's law, 9-11

Ohm's triangle, 9

OLED (Organic LED) displays, 45

laptops, 406

Online drive status (Disk Management), 221

Online (Errors) drive status (Disk Management), 221

Open Database Connectivity (ODBC), 254

open-ended questions, 163

open source operating systems, 458

Open Systems Interconnection (OSI). *See* OSI (Open Systems Interconnection)

OpenGL (Open Graphics Library), 183

opening

cases, 106-107

files, 236

operating systems (OS), 4, 181, 184

accessories, 259-260

Administrative Tools, 252

Component Services, 254

Computer Management console, 252-253

Data Sources, 254

Event Viewer, 253

Performance Monitor, 255-256

Services console, 254

Windows Memory Diagnostic, 255-256

Android, configuring email, 481

application management, 183

applications, properties, 229

boot process, 214-217

client-side virtualization, 268-271

closed source, 458

command-line interface (CLI), 264-265

Run Line utility, 265-268

Control Panel utilities, 239-247

Action Center, 245-246

Device Manager, 250-251

Display Settings, 243-244

Folder Options, 245

Internet Options, 242-243

Power Options, 247-248

Regional and Language Options, 252

System, 248-250

User Accounts, 241-242

Windows Firewall, 246-247

customer requirements, 187-189

desktop, 185

Apple OS X, 186

Linux, 186

Microsoft Windows, 185-186

directory structures, 224

drive mapping, 224

mounting volumes, 224-225

file systems, 198-199

files

attributes, 227-228

extensions, 227-228

locations, 225-227

management, 182

properties, 229

folders

management, 182

properties, 229

GUI (graphical user interface), 230-239

hardware access, 182

hardware requirements, 188-189

infected, remediation, 572-573

installing, 196

account creation, 203-204

completing, 204-206

custom options, 207-214

default settings, 200-202

hard drive formatting, 198-200

hard drive partitioning, 196-198

system recovery options, 211-214

iOS, configuring email, 481-482

malicious software, 571

mobile devices, 458-460
Android, 461-466
iOS, 466-470
 multiboot procedures, 218-223
 multiprocessing, 181
 multitasking, 181
 multithreading, 181
 multiuser, 181
 network configuration, 365-372
 network operating systems (NOS), 186-187
 open source, 458
 OS, 181
 patches, 589-590
 preventative maintenance, 271
hard drive backups, 277-278
plans, 271-273
restore points, 276-277
scheduling tasks, 274-275
updates, 273-274
 processor architecture, 183-184
 Registry, 217-218
 service packs, 589-590
 Shadow Copy, 230
 System Tools, 256
Disk Defragmenter, 256-258
Disk Error-Checking tool, 256-258
System Information, 258-259
 troubleshooting, 279, 641, 648-650, 656-657
common problems, 282-283, 287
common problems and solutions, 643-648, 652-656
documentation, 282, 643-652
full system functionality verification, 281, 642, 651
identifying problem, 279, 641, 650
implementing solution, 281, 642, 651
testing theory, 280, 642
theory of probable cause, 280, 641, 650-651
 upgrading, 192-199
compatibility, 192-193
data migration, 195-196
Upgrade Advisor, 192
Windows, 193-195
 user interfaces, 182
 Windows 7, Control Panel utilities, 261-262
 Windows Vista, Control Panel utilities, 263
 Windows XP, Control Panel utilities, 264

optical drive status indicator, laptops, 398
 optical drives, 27-28
 installing, 113-114
 laptops, 398
 cleaning, 440
 replacing, 432
 selecting, 62
 optical fibers, 336
 optimization, printers, 520-522
 organic LED (OLED) displays, 45
 laptops, 406
 organizational tools, properly using, 89-91
 OS (operating systems). *See* operating systems (OS)
 OSHA (Occupational Safety and Health Administration), 82
 OSI (Open Systems Interconnection) data model, 345
 output devices, 44
 all-in-one printers, 46
 headphones, 46
 monitors, 44-46
 projectors, 44-46
 speakers, 46
 overclocking CPUs, 16, 133

P

packets, 307, 324
 filters, 581
 Page Description Language (PDL), 515
 pages per minute (ppm), printers, 505
 PANs (personal area networks), 304
 parallel data transfer connections, printers, 507
 parallel ports, 23, 38
 docking stations, 404
 parity memory, 22
 part retrievers, 86
 partitions
 extending, Disk Management utility, 222
 factory recovery, 214
 hard disk drives, 196-198
 splitting, Disk Management utility, 222
 parts labels, 91
 parts organizers, 86
 password locks, mobile devices, 485-486

passwords

- BIOS, 133
- protection levels, 560
- screensavers, 561
- security policy, 559-560
 - requirements, 560-561*
- strong, 560

PATA data cables, 114, 120

- installing, 121-122
- PATA (EIDE) 80-conductor data cable, 31
- PATA (IDE/EIDE) 40-conductor data cable, 31
- PATA (Parallel ATA) interface, 28

patches

- mobile device operating systems, 491
- operating systems, 589-590

PC Card/ExpressCard slot, docking stations, 404**PC cards, laptops, 396, 419-420****PC combo expansion slot, laptops, 397****PCI Express expansion slots, 24****PCI Express Micro, laptops, 418****PCI-Extended (PCI-X) expansion slots, 25****PCI (Peripheral Component Interconnect) expansion slots, 23****PCI (Peripheral Component Interconnect) wireless NICs, installing, 116-117****PCIe NICs, installing, 116****PCIe x16 video adapter cards, installing, 117-118****PCL (Printer Command Language), 515****PCs, virtual machines, 268-269**

- requirements, 270-271

PDC (Personal Digital Cellular), 475**PDL (Page Description Language), 515****PDU (protocol data units), 346****PE (Preinstallation Environment), 211****PEAP (Protected Extensible Authentication Protocol), 579****peer-to-peer networks, 305-306****Pen and Input Devices utility (Windows Vista), 263****pencils, 96****per document method, printer configuration, 520****Performance Monitor (Administrative Tools), 255-256****Peripheral Component Interconnect (PCI) expansion slots, 23****peripherals, troubleshooting, 634-640**

- common problems and solutions, 637-639
- documentation, 637
- full system functionality verification, 636
- identifying problem, 634
- implementing solutions, 636
- testing theory, 635
- theory of probable cause, 635

permission propagation, 565**permissions**

- files, 561-564
 - principle of least privilege, 564*
 - restricting, 565*
- folders, 561-564
 - principle of least privilege, 564*
 - restricting, 565*
- levels, 561-565
- troubleshooting, 674

persistent data, 622**personal area networks (PANs), 304****Personal Digital Cellular (PDC), 475****personal reference tools, 90****PGA (pin grid array) CPUs and sockets, 14****Phillips-head screwdrivers, 85, 95****Phillips-head screws, replacing with flat-head screw, 140****phishing, 545-546****physical network topologies, 337-340****physical threats, 544****piezoelectric inkjet nozzles, 508****PIN cards, 588****pin grid array (PGA) CPUs, 14****pinching touchscreens, 457****ping command, 318, 348, 362****pinouts, 334****pixels, 47****plain old telephone service (POTS), 373, 377****planning preventative maintenance, 271-273****plasma displays, 46**

- laptops, 406

plastics, laptops, replacing, 436-437**plenum cable, 334****plug-and-play (PnP) process, 182****PnP (plug-and-play) process, 182****PoE (Power over Ethernet) switches, 325****Point-to-Point Protocol (PPP), 323**

- policies (security), 557**
 - biometrics, 567
 - communication encryption, 575-577
 - data backups, 568
 - data encryption, 569-570
 - demilitarized zone (DMZ), 582-583
 - hardware firewalls, 581-582
 - key fobs, 568
 - MAC address filtering, 578
 - malicious software protection programs, 571-573
 - passwords, 559-561
 - permission levels, 561-565
 - physical equipment protection methods, 585-586
 - port forwarding, 583-584
 - port triggering, 584
 - requirements, 557-559
 - security hardware, 586-589
 - service set identifiers (SSID), 577
 - signature file updates, 573-574
 - smart cards, 568
 - software firewalls, 565-567
 - usernames, 559
 - wireless access, 579-581
 - wireless security modes, 578-579
- pop-up blockers, 548-549**
- POP3 (Post Office Protocol Version 3), 479**
- port forwarding, 583-584**
- port replicators, laptops, 403-404**
- port triggering, 584**
- ports, 320**
 - I/O (input/output), 35-41
 - video, 32-33
 - well-known, 321
- position control, monitors, 48**
- POST (power-on self-test) cards, 128, 163**
- Post Office Protocol Version 3 (POP3), 479**
- PostScript, 510, 515**
- POTS (plain old telephone service), 373, 377**
- power adapters, laptops, 396**
- power button, 123**
- power cables, installing, 118-120**
- power color codes, 8**
- Power Control widget (Android), 464**
- power devices, inspecting, 160**
- power, electrical, 9**
- power fluctuations, 80-81**
- power LEDs, 124**
- power management, laptops, 408**
 - ACPI settings, 409-410
 - Power Options utility, 410-412
- power-on self-test (POST), 128, 163**
- Power Options (Control Panel), 247-248**
- Power Options utility, 410-412**
- Power over Ethernet (PoE) switches, 325**
- power protection devices, 81**
- power supplies, 4-7**
 - capacitors, 11
 - common problems and solutions, 172-173
 - connectors, 7-8
 - installing, 107-108
 - Ohm's law, 9-11
 - selecting, 49-50
 - uninterruptible power supply (UPS), 7
 - units of electricity, 8
- power supply testers, 97**
- power surges, 81**
- power systems, Home Theater Personal Computers (HTPCs), 69**
- ppm (pages per minute), printers, 505**
- PPP (Point-to-Point Protocol), 323**
- Preboot Execution Environment (PXE)**
 - Installation, 208
- Preinstallation Environment (PE), 211**
- preventive maintenance, 156**
 - benefits, 156-157
 - cleaning case, 158-159
 - cleaning internal components, 158-159
 - environmental concerns, 160
 - implementing, 168
 - inspecting internal components, 159-160
 - laptops, 437
 - cleaning procedures, 439-440*
 - scheduling maintenance, 437-438*
 - networks, 379-380
 - operating systems, 271
 - hard drive backups, 277-278*
 - plans, 271-273*
 - restore points, 276-277*
 - scheduling tasks, 274-275*
 - troubleshooting, 279*
 - updates, 273-274*
 - printers, 528-532
 - tasks, 157

- primary partitions, 197
- principle of least privilege, 564
- print servers, 526-528
- printer cartridges, proper disposal, 84
- Printer Command Language (PCL), 510, 515
- printer toner kits, proper disposal, 84
- printers, 46, 504, 537
 - black and white, 505
 - capabilities, 505
 - cleaning, 530-532
 - color, 505
 - common features, 504
 - common problems and solutions, 536
 - configuring, 518-520
 - control panel, 518
 - dots per inch (dpi), 505
 - drivers, 514-515
 - installing, 515-518*
 - impact, 511-512
 - inkjet, 508
 - installing, 513-514
 - laser, 509
 - printing process, 509-511*
 - memory, 521-522
 - optimizing performance, 520-522
 - pages per minute (ppm), 505
 - preventive maintenance, 528-532
 - printing test pages, 516-518
 - quality, 505
 - reliability, 505
 - sharing, 523-526
 - speed, 505
 - testing, 516-518
 - thermal, 511
 - total cost of ownership (TCO), 506
 - troubleshooting, 532-536, 665, 669-670
 - common problems and solutions, 668*
 - documentation, 667*
 - identifying problem, 665*
 - implementing solutions, 666*
 - testing theory, 666*
 - theory of probable cause, 665*
 - wired connection types, 506-507
 - wireless, sharing, 525-526
- Printers and Faxes utility (Windows XP), 264
- Printers utility (Windows Vista), 263
- Privacy tab (Internet Options), 242
- private key encryption, 576
- Problem Reports and Solutions utility (Windows Vista), 263
- problems, identifying, 162-166
- processing step, laser printing, 510
- processors. *See also* CPUs (central processing units)
 - architecture, 183-184
 - laptops, 402
- professionalism, communication skills, 609
- profiles, 567
- Program Files folder, 227
- programmable read-only memory (PROM), 19
- programs, 4
- Programs tab (Internet Options), 242
- projectors, 44-46
- PROM (programmable read-only memory), 19
- propagation, permissions, 565
- proper netiquette, 615-616
- properties
 - applications, 229
 - desktop, 232-233
 - files, 229
 - folders, 229
- Protected Extensible Authentication Protocol (PEAP), 579
- protocol data units (PDU), 346
- protocols, 319
 - application layer, 344
 - Dynamic Host Configuration Protocol (DHCP), 315-317
 - email
 - IMAP (Internet Message Access Protocol), 480*
 - MIME (Multipurpose Internet Mail Extension), 480*
 - POP3 (Post Office Protocol Version 3), 479-480*
 - SMTP (Simple Mail Transport Protocol), 480*
 - SSL (Secure Sockets Layer), 480*
- Ethernet, 342
- Extensible Authentication Protocol (EAP), 579
- Internet Control Message Protocol (ICMP), 317
- Internet layer, 344
- IP (Internet protocol), 309-313
- network access layer, 345
- PPP (Point-to-Point Protocol), 323
- Protected Extensible Authentication Protocol (PEAP), 579

protocol data units (PDU), 346
 TCP/IP, 343-347
 attacks, 552-554
 Temporal Key Integrity Protocol (TKIP), 359-579
 Transmission Control Protocol (TCP), 319-322
 Transmission Control Protocol/Internet Protocol (TCP/IP), 309
 transport layer, 344
 user datagram protocol (UDP), 319-322
 proximity sensors, smartphones, 457
 proxy firewalls, 582
 proxy settings, troubleshooting, 675
 PS/2 ports, 40
 PSTN (public switched telephone network), 327
 public key encryption, 576
 public networks, 355
 public switched telephone network (PSTN), 327
 punch down tools, 86
 push and pull installation, applications, 460
 PXE operating system installation, 209

Q

QoS (Quality of service), 353
 QR (Quick Response) codes, 459
 quad-band, 375
 quad-core CPUs, 16
 quality, print, 505
 Quality of service (QoS), 353
 quick format, versus full format, 200
 Quick Response (QR) codes, 459

R

radio frequency interference (RFI), 80
 RAID (redundant array of independent disks), 29-30
 adapter, 23
 upgrading, 145-146
 RAM (random access memory)
 CAx workstations, 65
 gaming PCs, 68
 inspecting connections, 159
 installing, 111
 laptops, 401-402
 SODIMM, 422-424

 selecting, 53
 upgrading, 142-143
 virtualization workstations, 67
 RAM access panel, laptops, 398
 Rambus DRAM (RDRAM), 20
 rambus in-line memory module (RIMM), 21
 random-access memory (RAM). *See* RAM (random access memory)
 RCA connectors, 33
 RDRAM (Rambus DRAM), 20
 REACH (Registration, Evaluation, Authorization and restriction of Chemicals), 83
 rear view, laptops, 396
 recycling hard drives, 556
 Reduced Instruction Set Computer (RISC) chips, 15
 redundant array of independent disks (RAID). *See* RAID (redundant array of independent disks)
 reference tools, 89-90
 reflective IR networks, 415
 refresh rate, 47
 REGEDIT command (Run Line), 267
 Regional and Language Options (Control Panel), 252
 registers, CPUs, 183
 Registration, Evaluation, Authorization and restriction of Chemicals (REACH), 83
 Registry (Windows), 217-218
 backup types, 592
 reliability, printers, 505
 remediation, infected systems, 572-573
 remote backup, smart devices, 487-488
 Remote Desktop, 259-260
 Remote Installation Services (RIS), 210
 remote lock, smart devices, 489
 remote operating system installation, 208
 remote wipe, smart devices, 489
 RemoteApp and Desktop Connections utility (Windows 7), 262
 repairing boot problems, 640
 replacing
 laptop batteries, 426-427
 laptop CPUs, 434-435
 laptop DC jacks, 427-428
 laptop displays, 430-431
 laptop hard drives, 431-432
 laptop keyboards, 428-429
 laptop optical drives, 432

- laptop plastics, 436-437
- laptop speakers, 433
- laptop system boards, 436
- laptop touchpads, 429-430
- laptop wireless cards, 433
- replay attacks, 553
- requirements
 - passwords, 560-561
 - security policy, 557-559
- reset button, 123
- reset control, monitors, 48
- resistance, electrical, 9
- resistive touchscreens, 456
- resolutions, displays, 46
- restore points, 212, 276-277
- Restore Utility Wizard, 592
- restricting user permissions, 565
- retina scans, 567
- RFI (radio frequency interference), 80
- RG-6 coaxial cable, 332
- RG-59 coaxial cable, 332
- RIMM (rambus in-line memory module), 21
- ring network topology, 338-339
- RIS (Remote Installation Services), 210
- RISC (Reduced Instruction Set Computer) chips, 15
- Rivest, Ron, 576
- RJ 11 (modem port), docking stations, 404
- RJ-45 connectors, 34
- rogue antivirus attacks, 571-572
- ROM (read-only memory), 18-19
- rooting, Android OS, 491
- rootkits, 547
- routers, 325-326
 - basic network setup, 356-357
 - basic wireless setup, 358-360
 - connecting to, 353-354
 - logging in to, 356
 - testing connectivity, 360-365
- RSA asymmetric encryption, 576
- rude customers, dealing with, 613
- Run Line utility, 266-268

S

- S video
 - cables, 34
 - connectors, laptops, 397
 - keyboard, video, mouse (KVM), 42
- Safe Mode, 217
- Safe Mode with Command Prompt, 217
- Safe Mode with Networking, 217
- SATA (Serial ATA) data cables, 31, 114, 121
 - installing, 121-122
- SATA (Serial ATA) interface, 28
- SATA (Serial ATA) keyed connector, 7
- SATA (Serial ATA) power connectors, 119
 - installing, 119-120
- satellite ISP connections, 376-378
- SC fiber-optic connectors, 337
- ScanDisk, 88
- scanners, 44
- scatter IR networks, 415
- SCCM (System Center Configuration Manager), 208
- scheduled servicing, printers, 505
- scheduling
 - maintenance, laptops, 437-438
 - tasks, 274-276
- screen brightness, mobile devices, 471
- screen calibration, mobile devices, 471
- screen orientation, mobile devices, 470-471
- screensavers, passwords, 561
- screws, 94-95
 - inspecting, 159
 - replacing, 140
- screws, metal shavings, 140
- scrolling touchscreens, 457
- SCSI (Small Computer System Interface), 28
 - adapter, 23
 - connections, printers, 507
 - data cable, 31
 - ports, 38-39
- SD (secure digital) cards, 61
- SDRAM (synchronous DRAM), 20
- Search tab (Folder Options), 245
- SEC sockets, 141
- second generation (2G) digital standards, 475
- sectors, partitions, 198
- secure digital (SD) cards, 61

- Secure Hash Algorithm (SHA), 575
- secure Internet connections, troubleshooting, 654-655
- Secure Sockets Layer (SSL), 480
- security, 544, 602
 - antivirus software, 547
 - email, spam, 551-552
 - maintenance, 589
 - configuring firewalls*, 593-595
 - data backups*, 591-593
 - maintaining accounts*, 595-596
 - operating system patches*, 589-590
 - operating system service packs*, 589-590
 - mobile devices, 485
 - antivirus software*, 490-491
 - failed login attempt restrictions*, 486-487
 - password locks*, 485-486
 - patches and updates*, 491
 - network cabling, 331
 - policy, 557
 - biometrics*, 567
 - communication encryption*, 575-577
 - data backups*, 568
 - data encryption*, 569-570
 - demilitarized zone (DMZ)*, 582-583
 - hardware firewalls*, 581-582
 - key fobs*, 568
 - MAC address filtering*, 578
 - malicious software protection programs*, 571-573
 - passwords*, 559-561
 - permission levels*, 561-565
 - physical equipment protection methods*, 585-586
 - port forwarding*, 583-584
 - port triggering*, 584
 - requirements*, 557-559
 - security hardware*, 586-589
 - service set identifiers (SSID)*, 577
 - signature file updates*, 573-574
 - smart cards*, 568
 - software firewalls*, 565-567
 - usernames*, 559
 - wireless access*, 579-581
 - wireless security modes*, 578-579
 - threats
 - adware*, 545
 - data*, 544
 - data wiping*, 555
 - degaussing*, 555
 - external*, 544
 - grayware*, 545
 - hard drive destruction*, 556
 - internal*, 544
 - phishing*, 545-546
 - physical*, 544
 - rogue antivirus*, 571-572
 - rootkits*, 547
 - spyware*, 545
 - Trojan horses*, 546
 - viruses*, 546
 - worms*, 546
 - troubleshooting, 596, 676-677
 - common problems and solutions*, 599-601, 673-675
 - documentation*, 599, 672
 - firewalls*, 675
 - full system functionality verification*, 598, 672
 - identifying problem*, 596, 670
 - implementing solution*, 671
 - malware*, 673
 - permissions*, 674
 - proxy settings*, 675
 - resolving problems*, 598
 - testing theory*, 597, 671
 - theory of probable cause*, 597, 671
 - user accounts*, 674
 - web, 547
 - ActiveX filtering*, 548
 - InPrivate browsing*, 550-551
 - pop-up blockers*, 548-549
 - SmartScreen Filter*, 549-550
 - social engineering*, 554
 - TCP/IP attacks*, 552-554
- security configurations, BIOS, 133-134
- security key fobs, 568
- security keyhole, laptops, 397
- Security tab (Internet Options), 242
- segments, 324
- serial data transfer connections, printers, 506
- serial ports, 23, 35-36
 - docking stations, 404
- servers, print, 526-528
- service level agreements (SLAs), 628
 - observing, 618

- service packs, operating systems, 589-590
- service set identifier (SSID), 358, 577
- Services console (Administrative Tools), 254
- SERVICES.MSC command (Run Line), 267
- Setup Backup utility (Action Center), 246
- SFC (System File Checker) command-line tool, 88
- SHA (Secure Hash Algorithm), 575
- Shadow Copy, 230
- Shamir, Adi, 576
- shared resources, 301
- sharing printers, 523-526
- shielded twisted-pair (STP), 333
- Short Message Service (SMS), 375, 476
- sideloading applications, 460
- signature files, updates, 573-574
- signatures, digital, 574-576
- signed drivers, 148
- Silverlight (Microsoft), 548
- SIM (Subscriber Identity Module) cards, mobile devices, 455
- SIM (System Image Manager), 209
- SIMM (single in-line memory module), 20
- Simple Mail Transport Protocol (SMTP), 480
- simplex data transmissions, 308
- single-core CPUs, 16
- single in-line memory module (SIMM), 20
- single-mode fiber-optic cable, 337
- Siri, 467
- site surveys, 340
- SLAs (service level agreements), 628
 - observing, 618
- Sleep mode, laptops, 410
- sleep timers, laptops, 412
- slides, touchscreens, 456
- slot-based CPUs, 14
- Small Computer System Interface (SCSI). *See* SCSI (Small Computer System Interface)
- small office, home office (SOHO) environments, 185
- small outline DIMM (SODIMM), 21
- small outline dual in-line memory modules (SODIMM), 401-402
- smart cards, 568
- smart devices, cloud-enabled services
 - locator applications, 488-489
 - remote backup, 487-488
 - remote lock, 489
 - remote wipe, 489
- smartphones. *See also* mobile devices
 - proximity sensor, 457
- SmartScreen Filter, 549-550
- SMS (Short Message Service), 375, 476
- SMTP (Simple Mail Transport Protocol), 480
- social engineering, 554
- sockets, central processing units (CPUs), 14
- SODIMM (small outline dual in-line memory modules), 21, 401-402
- SODIMM memory, laptops, 422-424
- soft token programs, 588
- software, 4. *See also* operating systems
 - diagnostic, 89
 - disk management tools, 88
 - email, mobile devices, 479-482
 - firewalls, 565-567
 - help desk, 625
 - IP phones, 328
 - malicious software protection programs, 571-573
 - malware, settings, 673
 - mobile devices
 - antivirus*, 490-491
 - patches and updates*, 491
 - preventive maintenance tasks, 157
 - printers, optimization, 521
 - tools, properly using, 88-89
- SOHO (small office, home office) environments, 185
- solid state drives (SSDs), 27
 - destruction, 556
 - mobile devices, 457-458
 - selecting, 60
- Sony/Philips Digital Interface Format (S/PDIF) port, 40
- sound adapters, 23
- sound cards
 - gaming PCs, 68
 - selecting, 55
- Southbridge controls, 13
- spam email, 551-552
- speakers, 46
 - Bluetooth, 477
 - laptops, 398
 - replacing*, 433
- special function keys, laptops, 402-403
- specialized computer systems, 64
 - audio and video editing workstations, 65-66
 - CAX workstations, 65

- gaming PCs, 68-69
- Home Theater Personal Computers (HTPCs), 69-70
- virtualization workstations, 67
- speed, printers, 505
- SPI (stateful packet inspection) firewalls, 581
- spikes, power, 81
- splitting partitions, Disk Management utility, 222
- spoofing attacks, 553
- Spotlight search (iOS), 468
- spreads, touchscreens, 457
- SPS (standby power supply), 81
- spyware, 545
- SRAM (static RAM), 19-22
- SSDs (solid state drives), 60
 - destruction, 556
- SSID (service set identifiers), 358, 577
- SSL (Secure Sockets Layer), 480
- ST fiber-optic connectors, 337
- standard formats, hard drives, 556
- Standby mode, laptops, 411
- standby power supply (SPS), 81
- star network topology, 338-339
- Start menu, 233-234
- start test, BIOS, 136
- startup modes, 217
- startup programs, preventive maintenance, 272
- Startup Repair option (System Recovery), 212
- stateful packet inspection (SPI) firewalls, 581
- static IP addressing, 314-315
- static RAM (SRAM), 19, 22
- stereo controls, Bluetooth, 477
- stereo headphone jack, laptops, 397
- storage devices, 25-28
 - common problems and solutions, 169-171
 - gaming PCs, 69
 - inspecting, 159
- storage controllers, selecting, 55-56
- STP (shielded twisted-pair), 333
- straight-through cables, 335
- stress management techniques, 616-617
- strong passwords, 560
- subnet masks, IPv4, 312-313
- subnetting, 313
- Subscriber Identity Module (SIM) cards, mobile devices, 455
- supervisor password (BIOS), 133
- surge suppressors, 81
- surround-sound audio, Home Theater Personal Computers (HTPCs), 69
- swipes, touchscreens, 456
- switches, 324-325
 - keyboard, video, mouse (KVM), 42
 - Power over Ethernet (PoE) switches, 325
 - voltage selector, 10
- symmetric encryption, 575-576
- SYN flood attacks, 552
- synchronization, mobile devices, 482-484
- Synchronous DRAM (SDRAM), 20
- system boards, laptops, replacing, 436
- System Center Configuration Manager (SCCM), 208
- System File Checker (SFC) command-line tool, 88
- System folder, 225
- system icons, Android OS home screen, 462-463
- System Image Manager (SIM), 209
- System Image Recovery option (System Recovery), 212
- System Image Recovery utility, 213
- System Information tool, 258-259
- system recovery options, operating system installation, 211-214
- System Restore option (System Recovery), 211-212
- System Restore utility, 277
- system speakers, 124
- System Tools, 256
 - Disk Defragmenter, 256-258
 - Disk Error-Checking tool, 256-258
 - System Information, 258-259
- System utility (Control Panel), 248-250

T

- Tablet PC settings (Windows Vista), 263
- talkative customers, dealing with, 613
- tape drives, 27
- Task Manager, 165, 234-235
- Task Scheduler, 274-276
- taskbar, 234
- tasks, scheduling, 274-276
- TCO (total cost of ownership), printers, 506
- TCP (transmission control protocol), 319-322

TCP/IP (Transmission Control Protocol/Internet Protocol), 309

attacks, 552-554

data model, networks, 343-347

TD-SCDMA (Time Division Synchronous Code Division Multiple Access), 476**technicians**

level one, 626-627

level two, 627

Telecommunications Industry Association and Electronic Industries Alliance (TIA/EIA), 341**temperatures, monitoring, 134****Temporal Key Integrity Protocol (TKIP), 359, 579****Temporary Files folder, 226-227****test pages, printing, 516-518****testing**

printers, 516-518

theory of probable cause, 166-167

UTP cables, 98

tethering mobile devices, 477**theory of probable cause, 166, 533**

testing, 166-167

thermal compound, CPUs, 109, 141**thermal inkjet nozzles, 508****thermal printers, 511****Thicknet coaxial cable, 332****Thinnet 10BASE2 coaxial cable, 332****third-generation (3G) standards, 475****third-party software, installing, 239****threats**

adware, 545

data, 544

data wiping, 555

degaussing, 555

external, 544

grayware, 545

hard drive destruction, 556

internal, 544

phishing, 545-546

physical, 544

rogue antivirus, 571-572

rootkits, 547

social engineering, 554

spyware, 545

TCP/IP, 552-554

Trojan horses, 546

viruses, 546

worms, 546

throttling CPUs, 16, 402**time and date settings, BIOS, 131****Time Division Synchronous Code Division Multiple Access (TD-SCDMA), 476****time management, 616-617****TKIP (Temporal Key Integrity Protocol), 359, 579****tokens, 587****toner kits, proper disposal, 84****toner probes, 87****tools**

antistatic mats, using properly, 93-98

antistatic wrist straps, using properly, 92-93

cleaning materials, using properly, 98-100

diagnostic, 86-87

ESD, 85

hand, 85

hand tools, using properly, 94

hardware, using properly, 84-87

magnetized, 96

organizational, using properly, 89-91

software, using properly, 88-89

topologies (network), 337

determining, 340-341

logical, 337-340

physical, 337-340

Torx screwdrivers, 86**total cost of ownership (TCO), printers, 506****touch interface**

Android OS, 461

*home screen, 461-463**managing apps, 463-466**managing folders, 465**managing widgets, 464-465*

iOS

*home screen, 466-468**managing apps, 468-469**managing folders, 469-470***TouchFLO, Android OS home screen, 463****touchpads, laptops**

cleaning, 440

replacing, 429-430

touchscreens, 43

capacitive, 456

gestures, 456

- mobile devices, 456-457
- multi-touch, 456
- resistive, 456
- TPM (Trusted Platform Module), 569
- tracert command, 364
- tracks, 198
- transferring step, laser printing, 510
- Transmission Control Protocol (TCP), 319-322
- Transmission Control Protocol/Internet Protocol (TCP/IP). *See* TCP/IP (Transmission Control Protocol/Internet Protocol)
- transport layer protocols, 344
- triangulation, 489
- triple-core CPUs, 16
- Triple Data Encryption Standard (3DES), 575
- Trojan horses, 546
- troubleshooting, 156, 161
 - advanced, 634, 678
 - computer components*, 634-640
 - laptops*, 658-664
 - operating systems*, 641-657
 - peripherals*, 634-640
 - printers*, 665-670
 - security*, 670-677
 - beep codes, 163
 - BIOS information, 164
 - common problems and solutions, 169
 - CPUs*, 173-174
 - memory*, 173-174
 - motherboards*, 171-172
 - power supplies*, 172-173
 - storage devices*, 169-171
 - communication skills, 608-609
 - conversation etiquette, 162-163
 - data backups, 161-162
 - Device Manager, 164-165
 - diagnostic tools, 165
 - documentation, 168-169
 - responses*, 163
 - establishing plans of action, 167
 - Event Viewer, 164
 - identifying problems, 162-166
 - implementing preventive measures, 168
 - laptops, 441
 - common problems and solutions*, 443-446
 - documentation*, 443
 - full system functionality verification*, 443
 - identifying problem*, 441
 - implementing solution*, 442
 - testing theory*, 442
 - theory of probable cause*, 441
 - mobile devices
 - common problems and solutions*, 495-497
 - documentation*, 494
 - full system functionality verification*, 494
 - identifying problem*, 492
 - resolving problem*, 494
 - testing theory*, 493
 - theory of probable cause*, 493
 - networks, 380-382
 - full system functionality verification*, 382
 - identifying problem*, 380
 - resolving problem*, 381
 - testing theory*, 381
 - theory of probable cause*, 381
 - operating systems, 279
 - common problems*, 282-283, 287
 - documentation*, 282
 - full system functionality verification*, 281
 - identifying problem*, 279
 - implementing solution*, 281
 - testing theory*, 280
 - theory of probable cause*, 280
 - printers, 532-536
 - questions, 163
 - security, 596
 - common problems and solutions*, 599-601
 - documentation*, 599
 - full system functionality verification*, 598
 - identifying problem*, 596
 - resolving problem*, 598
 - testing theory*, 597
 - theory of probable cause*, 597
 - Task Manager, 165
 - theory of probable cause, 166
 - testing*, 166-167
 - verifying system functionality, 168
- Troubleshooting utility (Windows 7), 262
- Trusted Platform Module (TPM) chip, 134, 559
- TV tuners
 - cards, 23
 - Home Theater Personal Computers (HTPCs), 70

- tweezers, 86
- twisted-pair coaxial cables, 332-336
- two-factor authentication, 586
- Type C connectors, 34

U

- UDP (user datagram protocol), 319-322
- UMTS (Universal Mobile Telecommunications System), 476
- unattended operating system installation, 208-210
- uninstalling applications, 238
- uninterruptible power supply (UPS), 7, 81
 - plugging printers into, 514
- units of electricity, 6-8
- Universal Mobile Telecommunications System (UMTS), 476
- Universal Serial Bus (USB) ports, 23, 36-37
- unlike cables, 335
- Unreadable drive status (Disk Management), 221
- unshielded twisted-pair (UTP), 333
- unshielded twisted-pair (UTP) Ethernet network cables, 336
- updates
 - device drivers, 273
 - firmware, 274
 - mobile device operating systems, 491
 - operating systems, 274
 - signature files, 573-574
- updating NICs, 350-351
- Upgrade Advisor, 192
- upgrading
 - cooling systems, 141-142
 - CPUs, 141-142
 - hard disk drives, 144-145
 - I/O devices, 147-148
 - motherboard, 137-144
 - operating systems, 192-199
 - compatibility*, 192-195
 - data migration*, 195-196
 - RAID, 145-146
 - RAM, 142-143
- uploading, 374
- UPS (uninterruptible power supply), 7, 81
 - plugging printers into, 514
- USB (Universal Serial Bus) connections, printers, 507
- USB (Universal Serial Bus) hubs, 148
- USB (Universal Serial Bus) ports, 23, 36-37, 124
 - docking stations, 404
 - laptops, 397
- user accounts
 - operating systems, creating, 203-204
 - troubleshooting, 674
- User Accounts utility (Control Panel), 241-242
- user datagram protocol (UDP), 319-322
- user files, locations, 225
- user interfaces
 - command-line interface (CLI), 182
 - graphical user interface (GUI), 182-183
- user password (BIOS), 133
- user permissions. *See* permissions
- usernames, security policy, 559
- utilities
 - Control Panel, 239-241, 244, 247
 - Action Center*, 245-246
 - Device Manager*, 250-251
 - Display Settings*, 243-244
 - Folder Options*, 245
 - Internet Options*, 242-243
 - Power Options*, 247-248
 - Regional and Language Options*, 252
 - System*, 248-250
 - User Accounts*, 241-242
 - Windows Firewall*, 246-247
 - Disk Management, 220-221
 - adding arrays*, 223
 - adding drives*, 222
 - assigning drive letters*, 222
 - drive status*, 221
 - extended partitions*, 222
 - splitting partitions*, 222
- UTP (unshielded twisted-pair), 333
 - Ethernet network cables, 336
 - testing, 98

V

vacuum cleaners, 99
VDI (Virtual Desktop Infrastructure), 67
 vendor guidelines, printers, 528-529
 ventilation, laptops, 397
 vents
 computer cases, 6
 laptops, cleaning, 439
 vertical resolution, monitors, 48
VGA (Video Graphics Array)
 cables, 34
 docking stations, 404
 ports, laptops, 398
 video adapter cards, installing, 117-118
 video adapters, 23
 video and audio editing workstations, 65-66
 video cameras, 42
 video cards
 audio and video editing workstations, 66
 CAx workstations, 65
 gaming PCs, 68
 video ports, 32-33, 398
View archived messages (Action Center), 246
view only user access (BIOS), 133
View performance information (Action Center), 246
View tab (Folder Options), 245
Virtual Desktop
 installing external cables, 127
 motherboard installation, 112
 system requirements, 107
Virtual Desktop Infrastructure (VDI), 67
Virtual Machine Manager (VMM), 269-270
 virtual machines, 268-269
 requirements, 270-271
 Virtual Machine Manager (VMM), 269-270
 virtual private networks (VPNs), 371-372
 virtualization
 BIOS, 133
 client-side, 268-271
 workstations, 67
 virus protection software, 547
Virus Protection utility (Action Center), 246
 viruses, 546
VMM (Virtual Machine Manager), 269-270

voice control (iOS), 467
VoIP (Voice over IP) phones, 327-328
 volatile data, 622
 voltage, electrical, 8
 voltage of CPU, monitoring, 135
Voltage Regulator Module (VRM), 51
 voltage selector switches, 10
 volumes, mounting, 224-225
VPNs (virtual private networks), 371-372
VRM (Voltage Regulator Module), 51

W-Z

Wake on LAN (WoL) settings, NICs, 353
WANs (wide area networks), 304-305
 cellular, 375
 warranties
 laptops, 426
 printers, 505
Weather widget (Android), 464
web browsers, InPrivate browsing, 550-551
web security, 547
 ActiveX filtering, 548
 InPrivate browsing, 550-551
 pop-up blockers, 548-549
 SmartScreen Filter, 549-550
 social engineering, 554
 TCP/IP attacks, 552-554
web tools, 547
well-known ports, 321
WEP (Wired Equivalent Privacy), 359, 578
WER (Windows Error Reporting), 206
wide area networks (WANs), 304-305
widgets, Android, managing, 464-465
Wi-Fi antennas, 407
Wi-Fi hotspots, 489
Wi-Fi networks, 417-419
Wi-Fi On/Off widget (Android), 464
Wi-Fi Protected Access (WPA), 359, 579
Wi-Fi Protected Access 2 (WPA2), 359, 579
Wi-Fi Protected Setup (WPS), 581
Wi-Fi Sync, 484
WiMAX (Worldwide Interoperability for Microwave Access), 374, 476

Windows

- Administrative Tools, 252
 - Component Services*, 254
 - Computer Management console*, 252-253
 - Data Sources*, 254
 - Event Viewer*, 253
 - Performance Monitor*, 255-256
 - Services console*, 254
 - Windows Memory Diagnostic*, 255-256

- boot process, 214-215

- client-side virtualization, 268-271

- command-line interface (CLI), 264-265

- Run Line utility*, 266-268

- Control Panel utilities, 239-252

- GUI (graphical user interface), 230-239

- desktop*, 230-233

- Start menu*, 233-234

- taskbar*, 234

- preventive maintenance, 271

- hard drive backups*, 277-278

- plans*, 271-273

- restore points*, 276-277

- scheduling tasks*, 274-276

- troubleshooting*, 279

- updates*, 273-274

- Start menu, 233

- startup modes, 217

- System Tools, 256

- Disk Defragmenter*, 256-258

- Disk Error-Checking*, 256-258

- System Information*, 258-259

- troubleshooting

- common problems*, 282-287

- documentation*, 282

- full system functionality verification*, 281

- identifying problem*, 279

- implementing solution*, 281

- testing theory*, 280

- theory of probable cause*, 280

- upgrading, 193-195

Windows 7

- Action Center, 89

- Control Panel utilities, 261-262

- Enterprise operating system, 185

- Home Premium operating system, 185

- homegroup, 366-368

- installing printers, 514

- libraries, 237

- Professional operating system, 185

- Starter operating system, 185

- Ultimate operating system, 185

- Windows 7 Firewall**, 89

- windows, accessories, Remote Desktop**, 259-260

- Windows API**, 183

- Windows Automatic Updates utility**, 274

- Windows Boot Manager (BOOTMGR)**, 216, 219-220

- Windows Defender**, 262

- Windows Easy Transfer**, 195

- Windows Error Reporting (WER)**, 206

- Windows Explorer**, 236

- Windows Firewall (Control Panel)**, 246-247

- Windows Memory Diagnostic (Administrative Tools)**, 255-256

- Windows Memory Diagnostic option (System Recovery)**, 212

- Windows Preinstallation Environment (PE)**, 211

- Windows ReadyBoost (System utility)**, 249

- Windows Recovery Environment (WinRE)**, 211

- Windows Registry**, 217-218

- Windows Task Scheduler**, 274

- Windows Update**, 205

- Windows User State Migration Tool (USMT)**, 195

- Windows Virtual PC**, 269

Windows Vista

- Business operating system, 185

- Control Panel utilities, 262-263

- Enterprise operating system, 185

- Home Basic operating system, 185

- Home Premium operating system, 185

- installing printers, 514

- printer sharing, 528

- sharing resources, 368

- Ultimate operating system, 186

Windows XP

- 64-bit Professional operating system, 186

- Backup, 592

- Control Panel utilities, 263-264

- Home operating system, 186

- installing printers, 514

- Media Center operating system, 186

- Mode, 270

- printer sharing, 528
- Professional operating system, 186
- sharing resources, 369
- WinRE (Windows Recovery Environment), 211**
- wire cutters, 86
- wire strippers, 86
- Wired Equivalent Privacy (WEP), 359, 578**
- wired printers, connection types, 506-507
- wireless access points, 325-326, 579-581
- wireless adapters, laptops, 417-419
- wireless antennae, 580
- wireless cards, laptops, replacing, 433
- wireless communication, laptops, 413
 - Bluetooth, 413-415
 - cellular WAN cards, 417
 - connections, 300
 - IR (Infrared), 415-416
 - wireless adapters, 417-419
- wireless data networks, mobile devices, 473-474
- wireless local area networks (WLANs), 303
- wireless locators, 361
- wireless NICs, 23
 - installing, 116-117
- wireless printers, sharing, 525-526
- wireless routers
 - configuring, 358-360
 - testing connectivity, 360-365
- wireless security modes, 578-579
- WLANs (wireless local area networks), 303**
- WoL (Wake on LAN) settings, NICs, 353**
- work networks, 355
- workgroups, 366
- workstations
 - audio and video editing, 65-66
 - CAX, 65
 - data protection, 79-81
 - ergonomics, 616
 - proper tool usage, 84
 - antistatic mats, 93-98*
 - antistatic wrist straps, 92-93*
 - cleaning materials, 98-100*
 - hand tools, 94*
 - hardware tools, 84-87*
 - organizational tools, 89-91*
 - software tools, 88-89*
 - protecting environment, 82-84
 - protecting equipment, 79-81
 - safe procedures, 77-79
 - virtualization, 67
- Worldwide Interoperability for Microwave Access (WiMAX), 374**
- worms, 546
- WPA (Wi-Fi Protected Access), 359, 579**
- WPS (Wi-Fi Protected Setup), 581**
-
- x64 architecture, 184
- x86 architecture, 183
-
- zero insertion force (ZIF) lever, 14
 - levers and sockets, 141