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

Input and Output Devices (1.1.4)  41

Input Devices (1.1.4.1)  41
Mice and Keyboards  41
Gamepads and Joysticks  42
Digital Cameras and Digital Video Cameras  42
Biometric Identification Devices  43
Touchscreens  43
Digitizers  43
Scanners  44

Output Devices (1.1.4.2)  44
Monitors and Projectors  44
All-in-One Printers  46
Speakers and Headphones  46

Monitor Characteristics (1.1.4.3)  46
Connecting Multiple Monitors to a Single Computer  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
Graphics Cards  54
Sound Cards  55
Storage Controllers  55
I/O Cards  56
NICs  56
Capture Cards  57

Selecting Hard Drives and Floppy Drives (1.2.1.6)  57
Floppy Disk Drive  57
Hard Drives  57
Selecting Solid State Drives and Media Readers (1.2.1.7)  60
Solid State Drives  60
Media Readers  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
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
CPU 108
Heat Sink and Fan Assembly 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
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

Hardware 157

Software 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

Data Backup 161

Identify the Problem (4.2.1.2) 162

Conversation Etiquette 162

Open-Ended and Closed-Ended Questions 163

Documenting Responses 163

Beep Codes 163

BIOS Information 164

Event Viewer 164
Device Manager 164
Task Manager 165
Diagnostic Tools 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

Hardware Access 182
File and Folder Management 182
User Interface 182
Application Management 183
Processor Architecture (5.1.1.3) 183

Types of Operating Systems (5.1.2) 184
Desktop Operating Systems (5.1.2.1) 185
Microsoft Windows 185
Apple OS X 186
Linux 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
Microsoft Compatibility Center 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
RemoteApp and Desktop Connections 262
Troubleshooting 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
MSCONFIG 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
Windows Virtual PC 269
Windows XP Mode 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
Preventive Maintenance Planning 271
Security 272
Startup Programs 272
Updates (5.5.1.5) 273
Device Driver Updates 273
Operating System Updates 273
Firmware Updates 274
Scheduling Tasks (5.5.1.6) 274
Windows Task Scheduler 274
at Command 275
Restore Points (5.5.1.10) 276
Hard Drive Backup (5.5.1.14) 277
Normal Backup 278
Copy Backup 278
Incremental Backup 278
Differential Backup 278
Daily Backup 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
  *IPv4 and IPv6* 310
IPv4 (6.3.2.2) 311
  *IPv4 Subnet Mask* 312
IPv6 (6.3.2.3) 313
Static Addressing (6.3.2.4) 314
DHCP Addressing (6.3.2.5) 315
  *Configuring Alternate IP Settings* 317
  *DNS* 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
  *Hubs* 323
  *Bridges and Switches* 324
  *Power over Ethernet* 325
Routers and Wireless Access Points (6.4.1.3) 325
  *Wireless Access Points* 325
  *Routers* 326
  *Multipurpose Devices* 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
  *Cost* 331
  *Security* 331
  *Design for the Future* 331
  *Wireless* 331
Coaxial Cables (6.4.2.2) 332
Twisted-Pair Cables (6.4.2.3) 332
  *Category Rating* 333
  *Wire Schemes* 334
  *Straight-Through Cables* 335
  *Crossover Cable* 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
Channel 359
Wireless Security 359
Testing Connectivity with the Windows GUI (6.8.3.12) 360
Testing Connectivity with the Windows CLI (6.8.3.13) 361
  ipconfig Command Options 362
  ping Command Options 362
  net Commands 363
  tracert Command 364
  nslookup Command 364

OS Configurations (6.8.4) 365
  Domain and Workgroup (6.8.4.1) 365
    Domain 365
    Workgroup 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
    Network File Sharing 369
    Network Drive Mapping 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
    Analog Telephone 373
    Integrated Services Digital Network 373
    Broadband 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
    Cellular 375
    Cable 376
    Satellite 376
    Fiber Broadband 376
  Selecting an ISP for the Customer (6.9.1.7) 376
    POTS 377
    ISDN 378
    DSL 378
    Cable 378
    Satellite 378
    Cellular 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
  - Sideloading 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
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
  Capabilities and Speed  505
  Color or Black and White  505
  Quality  505
  Reliability  505
  Total Cost of Ownership  506

Wired Printer Connection Types (9.1.1.2)  506
  Serial  506
  Parallel  507
  SCSI  507
  USB  507
  FireWire  507
  Ethernet  507

Types of Printers (9.2)  507

Inkjet Printers (9.2.1.1)  508
  Printing Process  509

Laser Printers (9.2.1.2)  509

Thermal Printers (9.2.1.3)  511

Impact Printers (9.2.1.4)  511
  Types of Impact Printers  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
  Print Test Page  516
  Print from an Application  517
  Test the Printer  517
  Test the Printer from the Printer Panel  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
  Global Method  520
  Per Document Method  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) 534
  Verify 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
  Requiring Passwords  559
Password Requirements (10.2.1.5)  560
  Screensaver Required Password  561
File and Folder Permissions (10.2.1.6)  561
  Principle of Least Privilege  564
  Restricting User Permissions  565
Software Firewalls (10.2.2.1)  565
Biometrics and Smart Cards (10.2.2.2)  567
  Smart Card Security  568
  Security Key Fob  568
Data Backups (10.2.2.3)  568
Data Encryption (10.2.2.4)  569
Malicious Software Protection Programs (10.2.3.1)  571
  Rogue Antivirus  571
  Remediating Infected Systems  572
Signature File Updates (10.2.3.3)  573
Common Communication Encryption Types (10.2.4.1)  575
  Hash Encoding  575
  Symmetric Encryption  575
  Asymmetric Encryption  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
  Additions to WPA and WPA2  579
Wireless Access (10.2.4.6)  579
  Wireless Antennae  580
  Network Device Access  580
  Wi-Fi Protected Setup  581
Firewalls (10.2.4.7)  581
  Demilitarized Zone  582
Port Forwarding and Port Triggering (10.2.4.9)  583
Physical Equipment Protection Methods (10.2.5.1)  585
  Disabling AutoRun  585
  Two-Factor Authentication  586
Security Hardware (10.2.5.2)  586
  Protecting Data While in Use  587
  The Right Security Mix  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](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
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.

![Figure 2-1 MSDS](image)
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.
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.

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](image)

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](image)
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.
Chapter 2: Lab Procedures and Tool Use

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:

**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.

![Antistatic Mat](image)

**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.
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.
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
Chapter 2: Lab Procedures and Tool Use

- 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>
<thead>
<tr>
<th>Computer Cleaning Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer case and outside of monitor</strong></td>
</tr>
<tr>
<td><strong>LCD screen</strong></td>
</tr>
<tr>
<td><strong>CRT screen</strong></td>
</tr>
</tbody>
</table>
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.
   D. It will not harm computer components as long as the computer is plugged in.
   E. Keeping the air cool and dry can decrease the buildup of static electricity.
   F. 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 lighting?
   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
test 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
test 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
test 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
test 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
antispyware 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
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
data, installing, 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
cylindrical cables, 35, 332-336
capacitive touchscreens, 456
capacitors, 11
capture cards, 23
  selecting, 57
car speakerphones, Bluetooth, 477
card keys, 586
cameras, 42
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
despecialized, 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
e-mail 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
dedicated PC print servers, 527

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, 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
collaboration, 162-163
documenting responses, 163
documenting responses, 163
questions, 163
working with, 610-616
cyber laws, 622-623, 629
cylinders, 198

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 (deny 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
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
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
  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
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

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

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
gotagging, GPS (Global Positioning System), 472
gestures, touchscreens, 456
global method, printer configuration, 520
Global Positioning System (GPS), 489
mobile devices, 472-473
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  
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

termal, 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

ehome 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
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
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
ISP (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, 7-8
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
laptops, 395, 399-400, 447
   AC power adapters, 396
   backlight, 406-407
   batteries, 396-397
      replacing, 426-427
   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
   microphones, 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
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

troubleshooting 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

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
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, 23, 38
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
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
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
replacement of 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
scanners, 44
scatter IR networks, 415
SCCIT (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

e-mail, 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

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
TCP (transmission control protocol), 767

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 installa-
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
time and date settings, BIOS, 131
Thicknet coaxial cable, 332
Thinnet 10BASE2 coaxial cable, 332
third-generation (3G) standards, 475
third-party software, installing, 239

viruses, 546
worms, 546
throttling CPUs, 16, 402
time management, 616-617
TKIP (Temporal Key Integrity Protocol), 359, 579
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
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

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