MARK EDWARD SOPER
DAVID L. PROWSE
SCOTT MUELLER

CompTIA APPROVED QUALITY CONTENT

AUTHORIZED

Authorized Cert Guide

Learn, prepare, and practice for exam success

- Master every topic on the new **220-801 and 220-802** exams
- **Assess your knowledge** and focus your learning
- Get the practical workplace knowledge you need!
- Includes coverage of the new performance-based questions

CompTIA A+®

220-801
220-802

Third Edition

CD FEATURES TWO COMPLETE PRACTICE EXAMS

Includes
- 448 Practice Questions
- Sample Beep Codes
- Memory Tables
- Searchable Glossary

PEARSON IT CERTIFICATION

CompTIA A+ 220-801 and 220-802 Authorized Cert Guide

Third Edition

Mark Edward Soper
David L. Prowse
Scott Mueller

PEARSON

800 East 96th Street
Indianapolis, Indiana 46240 USA

CompTIA A+ 220-801 and 220-802 Authorized Cert Guide, Third Edition

ISBN-13: 978-0-7897-4850-8
ISBN-10: 0-7897-4850-9

Library of Congress Cataloging-in-Publication data is on file.

Printed in the United States of America

First Printing: September 2012

Trademarks

All terms mentioned in this book that are known to be trademarks or service marks have been appropriately capitalized. Pearson IT Certification cannot attest to the accuracy of this information. Use of a term in this book should not be regarded as affecting the validity of any trademark or service mark.

Warning and Disclaimer

Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied. The information provided is on an "as is" basis. The authors and the publisher shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this book or from the use of the CD or programs accompanying it.

Bulk Sales

Pearson IT Certification offers excellent discounts on this book when ordered in quantity for bulk purchases or special sales. For more information, please contact

U.S. Corporate and Government Sales

1-800-382-3419

corpsales@pearsontechgroup.com

For sales outside the United States, please contact

International Sales

international@pearsoned.com

Associate Publisher
Dave Dusthimer

Acquisitions Editor
Betsy Brown

Development Editor
Andrew Cupp

Managing Editor
Sandra Schroeder

Senior Project Editor
Tonya Simpson

Copy Editor
Apostrophe Editing Services

Proofreader
Megan Wade

Technical Editor
Chris Crayton

Editorial Assistant
Vanessa Evans

Media Producer
Tim Warner

Book Designer
Gary Adair

Compositor
Bronkella Publishing

Contents at a Glance

Table of Contents

About the Authors

Mark Edward Soper has been working with PCs since the days of the IBM PC/XT and AT as a salesperson, technology advisor, consultant, experimenter, and technology writer and content creator. Since 1992, he has taught thousands of students across the country how to repair, manage, and troubleshoot the hardware, software, operating systems, and firmware inside their PCs. He has created many versions of his experimental computer known as "FrankenPC" for this and previous books. Mark earned his CompTIA A+ Certification in 1999 and has written four other A+ Certification books covering previous and current versions of the A+ Certification exams for Pearson imprints.

Mark has contributed to many editions of *Upgrading and Repairing PCs*, working on the 11th through 18th and 20th editions; co-authored *Upgrading and Repairing Networks*, Fifth Edition; and has written two books about digital photography, *Easy Digital Cameras* and *The Shot Doctor: The Amateur's Guide to Taking Great Digital Photos*.

In addition, Mark has contributed to Que's *Special Edition Using* series on Windows Me, Windows XP, and Windows Vista and to Que's *Windows 7 In Depth*. He has also contributed to *Easy Windows Vista* and has written two books about Windows Vista: *Maximum PC Microsoft Windows Vista Exposed* and *Unleashing Microsoft Windows Vista Media Center*. Mark has also written two books about Windows 7: *Easy Microsoft Windows 7* and *Sams Teach Yourself Microsoft Windows 7 in 10 Minutes*. Mark has also created a number of hardware tutorial videos available from the OnGadgets&Hardware podcast channel at www.quepublishing.com.

Mark has also written many blog entries and articles for MaximumPC.com and *Maximum PC* magazine. He has taught A+ Certification and other technology-related subjects at Ivy Tech Community College in Evansville, Indiana. See Mark's website at www.markesoper.com for news and information about upcoming projects.

David L. Prowse is an author, a computer network specialist, and a technical trainer. Over the past several years he has authored several titles for Pearson Education, including the well-received *CompTIA A+ Exam Cram*. As a consultant, he installs and secures the latest in computer and networking technology. Over the past decade he has taught CompTIA A+, Network+, and Security+ certification courses, both in the classroom and via the Internet. He runs the website www.davidlprowse.com, where he gladly answers questions from students and readers.

Dedication

For Mayer and Naomi.

Acknowledgments

After more than 12 years as a full-time technology content provider, I'm more conscious than ever of two things—how richly I have been blessed by God in my family and in the team of technology experts I get to work with.

Thanks first and foremost to Almighty God. He gives gifts and strives earnestly to help us discover them.

Thanks also to my family, PC and Mac users alike, whose good-natured discussions keep everybody looking for the perfect technology. Thanks especially to Cheryl for her love and patience. A big thanks as well to Jeremy, for performing laptop teardowns and assisting with system builds.

As always, Pearson has put together an outstanding team for this edition, and I especially want to thank the two Daves: Dave Dusthimer for his vision of becoming the leading provider of A+ study material and Dave Prowse, my co-author, for helping make this book the best edition yet.

Thanks again to Scott Mueller, whose original edition of *Upgrading and Repairing PCs* was the impetus for taking my tech career to the next level, and for the opportunity to work with him on many projects over the years, including this one.

Thanks also to Betsy Brown, Andrew Cupp, Sandra Schroeder, and Tonya Simpson for keeping this process rolling along. And a big thank-you to technical editor Chris Crayton for great suggestions and tips along the way.

Finally, a thank you to Vanessa, Tim, and Gary.

All of us want to see you, our readers, succeed both in passing your exams and in your IT careers. We all wish you the very best.

About the Technical Editor

Chris Crayton is an author, technical editor, technical consultant, and trainer. Formerly, he worked as a computer and networking instructor at Keiser University; as network administrator for Protocol, a global electronic customer relationship management (eCRM) company; and at Eastman Kodak headquarters as a computer and network specialist. Chris has authored several print and online books on PC repair, CompTIA A+, CompTIA Security+, and Microsoft Windows. Mr. Crayton has also served as technical editor and contributor on numerous technical titles for many of the leading publishing companies. He holds MCSE, A+, and Network+ certifications.

We Want to Hear from You!

As the reader of this book, you are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

As an associate publisher for Pearson IT Certification, I welcome your comments. You can email or write me directly to let me know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that I cannot help you with technical problems related to the topic of this book. We do have a User Services group, however, where I will forward specific technical questions related to the book.

When you write, please be sure to include this book's title and author as well as your name, email address, and phone number. I will carefully review your comments and share them with the authors and editors who worked on the book.

Email: feedback@pearsonitcertification.com

Mail: David Dusthimer
Editor in Chief
Pearson IT Certification
800 East 96th Street
Indianapolis, IN 46240 USA

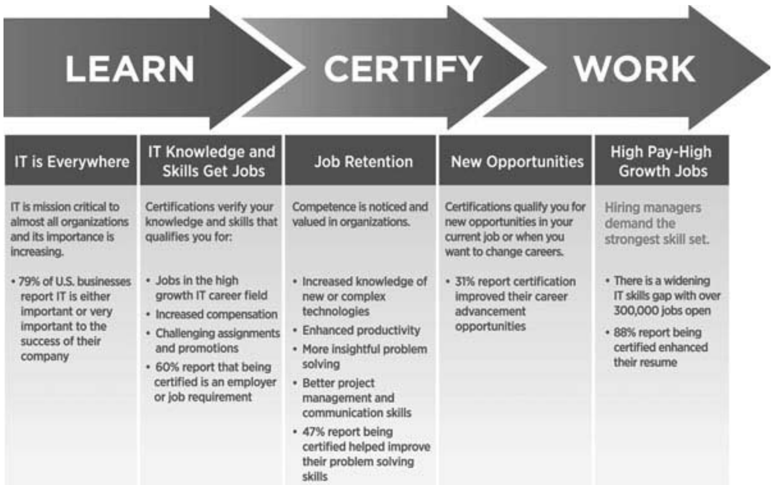
Reader Services

Visit our website and register this book at www.pearsonitcertification.com/register for convenient access to any updates, downloads, or errata that might be available for this book.

It Pays to Get Certified

In a digital world, digital literacy is an essential survival skill.

Certification proves you have the knowledge and skill to solve business problems in virtually any business environment. Certifications are highly-valued credentials that qualify you for jobs, increased compensation and promotion.



Certification Advances Your Career

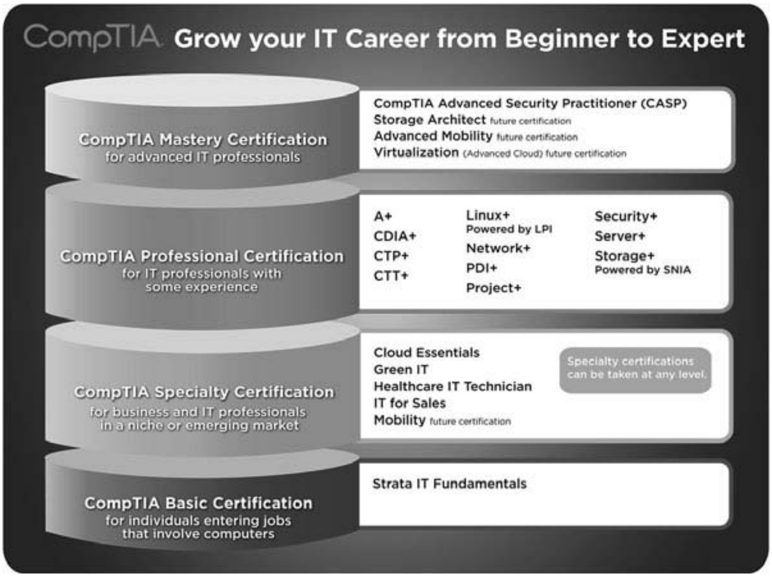
- The CompTIA A+ credential—provides foundation-level knowledge and skills necessary for a career in PC repair and support.
- Starting Salary—CompTIA A+ Certified individuals can earn as much as $65,000 per year.
- Career Pathway—CompTIA A+ is a building block for other CompTIA certifications such as Network+, Security+ and vendor specific technologies.
- More than 850,000—Individuals worldwide are CompTIA A+ certified.
- Mandated/Recommended by organizations worldwide—Such as Cisco and HP and Ricoh, the U.S. State Department, and U.S. government contractors such as EDS, General Dynamics, and Northrop Grumman.

Some of the primary benefits individuals report from becoming A+ certified are:

- More efficient troubleshooting
- Improved career advancement
- More insightful problem solving

CompTIA Career Pathway

CompTIA offers a number of credentials that form a foundation for your career in technology and allows you to pursue specific areas of concentration. Depending on the path you choose to take, CompTIA certifications help you build upon your skills and knowledge, supporting learning throughout your entire career.



Steps to Certification

Steps to Getting Certified and Staying Certified	
Review Exam Objectives	Review the certification objectives to make sure you know what is covered in the exam. http://www.comptia.org/certifications/testprep/examobjectives.aspx
Practice for the Exam	After you have studied for the certification, take a free assessment and sample test to get an idea what type of questions might be on the exam. http://www.comptia.org/certifications/testprep/practicetests.aspx
Purchase an Exam Voucher	Purchase your exam voucher on the CompTIA Marketplace, which is located at: www.comptiastore.com.
Take the Test!	Select a certification exam provider and schedule a time to take your exam. You can find exam providers at the following link: http://www.comptia.org/certifications/testprep/testingcenters.aspx

Join the Professional Community

Join IT Pro Community
http://itpro.comptia.org

The free IT Pro online community provides valuable content to students and professionals.

Career IT Job Resources

- Where to start in IT
- Career Assessments
- Salary Trends
- US Job Board

Forums on Networking, Security, Computing and Cutting Edge Technologies

Access to blogs written by Industry Experts

Current information on Cutting Edge Technologies

Access to various industry resource links and articles related to IT and IT careers

Content Seal of Quality

This courseware bears the seal of **CompTIA Approved Quality Content**. This seal signifies this content covers 100% of the exam objectives and implements important instructional design principles. CompTIA recommends multiple learning tools to help increase coverage of the learning objectives.

Why CompTIA?

- **Global Recognition**—CompTIA is recognized globally as the leading IT non-profit trade association and has enormous credibility. Plus, CompTIA's certifications are vendor-neutral and offer proof of foundational knowledge that translates across technologies.
- **Valued by Hiring Managers**—Hiring managers value CompTIA certification because it is vendor- and technology-independent validation of your technical skills.
- **Recommended or Required by Government and Businesses**—Many government organizations and corporations either recommend or require technical staff to be CompTIA certified. (For example, Dell, Sharp, Ricoh, the U.S. Department of Defense, and many more.)
- **Three CompTIA Certifications ranked in the top 10**—In a study by DICE of 17,000 technology professionals, certifications helped command higher salaries at all experience levels.

How to obtain more information

Visit CompTIA online: www.comptia.org to learn more about getting CompTIA certified.

Contact CompTIA: Call 866-835-8020 ext. 5 or email questions@comptia.org

Connect with us :

Introduction

CompTIA A+ Certification is widely recognized as the first certification you should receive in an information technology (IT) career. Whether you are planning to specialize in PC hardware, Windows operating system management, or network management, the CompTIA A+ Certification exams measure the baseline skills you need to master to begin your journey toward greater responsibilities and achievements in IT.

CompTIA A+ Certification is designed to be a vendor-neutral exam that measures your knowledge of industry-standard technology.

Goals and Methods

The number one goal of this book is a simple one: to help you pass the 2012 version of the CompTIA A+ Certification exams 220-801 and 220-802.

Because CompTIA A+ Certification exams now stress problem-solving abilities and reasoning more than memorization of terms and facts, our goal is to help you master and understand the required objectives for each exam.

To aid you in mastering and understanding the A+ Certification objectives, this book uses the following methods:

- The beginning of each chapter defines the topics to be covered in the chapter; it also lists the corresponding CompTIA A+ objective numbers.
- The body of the chapter explains the topics from a hands-on and a theory-based standpoint. This includes in-depth descriptions, tables, and figures geared to build your knowledge so that you can pass the exam. The chapters are broken down into several topics each.
- The key topics indicate important figures, tables, and lists of information that you should know for the exam. They are interspersed throughout the chapter and are listed in table format at the end of the chapter.
- You can find memory tables and lists on the disc as Appendix A, “Memory Tables,” and Appendix B, “Memory Tables Answer Key.” Use them to help memorize important information.
- Key terms without definitions are listed at the end of each chapter. Write down the definition of each term, and check your work against the complete key terms in the glossary.

- Hand-on labs test you on your knowledge of key concepts. Develop possible solutions and check your work against the answers at the end of the chapter.
- Each chapter includes review questions meant to gauge your knowledge of the subjects. If an answer to a question doesn't come readily to you, be sure to review that portion of the chapter. The answers with detailed explanations are at the end of each chapter.

What's New?

You'll find plenty that's new and improved in this edition, including

- Updated coverage of motherboard features
- New coverage of custom system configurations
- Updated processor coverage
- Updated BIOS dialogs including UEFI BIOS examples
- USB 3.0
- SATA 6.0Gbps
- SSDs and how to fine-tune them for best performance
- Laptop teardown procedures
- Updated display technologies
- Video and display troubleshooting
- New seven-step laser printing process
- Better coverage of color laser printers
- New coverage of dealing with prohibited content/activity
- Enhanced coverage of Windows features
- Enhanced discussion of Windows upgrade paths and methods
- Windows 7 Enterprise features
- Virtualization
- Windows Virtual PC and Windows XP Mode
- Improved Control Panel discussion
- New Mobility domain covering iOS and Android devices

- Best practices for security (physical, digital, wireless network, wired network, and workstation folders)
- Drive wiping and destruction methods
- Security troubleshooting
- Wireless network troubleshooting

For a number of years, the CompTIA A+ Certification objectives were divided into a hardware exam and an operating systems exam. Starting with the 2006 exam, the exams were restructured so that knowledge of hardware and operating systems were needed for both exams. With the 2012 edition, the exams have been restructured again in a way that, we believe, will help you prepare more easily and avoid duplication of information. 220-801 covers hardware topics and operational procedures, whereas 220-802 covers operating systems, security, a brand new mobile devices domain, and troubleshooting.

For more information about how the A+ certification can help your career, or to download the latest official objectives, access CompTIA's A+ webpage at www.comptia.org/certifications/listed/a.aspx.

One method used by many A+ certification authors is to simply follow the objectives step by step. The problem is that because different parts of the computer—such as hard disk, display, Windows, and others—are covered in many different objectives, this approach creates a lot of overlap between chapters and does not help readers understand exactly how a particular part of the computer fits together with the rest.

In this book, we have used a subsystem approach. Each chapter is devoted to a particular part of the computer so that you understand how the components of each part work together and how each part of the computer works with other parts. To make sure you can relate the book's contents to the CompTIA A+ Certification objectives, each chapter contains cross-references to the appropriate objectives as needed, and we provide a master cross-reference list later in this introduction.

Who Should Read This Book?

The CompTIA A+ exams measure the necessary competencies for an entry-level IT professional with the equivalent knowledge of at least 500 hours of hands-on experience in the lab or field. This book is written for people who have that amount of experience working with desktop PCs and laptops. Average readers will have attempted in the past to replace a hardware component within a PC; they should also understand how to navigate through Windows and access the Internet.

Readers will range from people who are attempting to attain a position in the IT field to people who want to keep their skills sharp or perhaps retain their job due to a company policy that mandates that they take the new exams.

This book is also aimed at the reader who wants to acquire additional certifications beyond the A+ certification (Network+, Security+, and so on). The book is designed in such a way to offer easy transition to future certification studies.

Strategies for Exam Preparation

Strategies for exam preparation will vary depending on your existing skills, knowledge, and equipment available. Of course, the ideal exam preparation would consist of building a PC from scratch and installing and configuring the operating systems covered including Windows 7 (Ultimate edition is recommended), Windows Vista (Ultimate edition is preferred), and Windows XP Professional. To make things easier for the reader, we recommend that you use Microsoft's Windows Virtual PC (which works with Windows 7 Professional, Ultimate, and Enterprise) or Virtual PC 2007 (which works with other Windows 7 editions, Windows Vista, and Windows XP). Either program enables you to run virtual operating systems from within your current operating system without the need for an additional computer and can be downloaded for free from Microsoft's website. We also recommend that you have access to a laptop, a laser printer, and as many peripheral PC devices as possible. This hands-on approach will really help to reinforce the ideas and concepts expressed in the book. However, not everyone has access to this equipment, so the next best step you can take is to read through the chapters in this book, jotting down notes with key concepts or configurations on a separate notepad. Each chapter contains a quiz that you can use to test your knowledge of the chapter's topics. It's located near the end of the chapter.

After you have read through the book, look at the current exam objectives for the CompTIA A+ Certification Exams listed at http://certification.comptia.org/home.aspx. If there are any areas shown in the certification exam outline that you would still like to study, find those sections in the book and review them.

When you feel confident in your skills, attempt the practice exams included on the disc with this book. As you work through the practice exams, note the areas where you lack confidence and review those concepts or configurations in the book. After you review the areas, work through the practice exam a second time and rate your skills. Keep in mind that the more you work through the practice exam, the more familiar the questions will become.

After you have worked through the practice exams a second time and feel confident with your skills, schedule the real CompTIA A+ 220-801 and 220-802 exams through either Sylvan Prometric (www.2test.com) or Pearson Vue (www.vue.com).

To prevent the information from evaporating out of your mind, you should typically take the exam within a week of when you consider yourself ready to take the exam.

The CompTIA A+ Certification credential for those passing the certification exams is now valid for 3 years (effective January 1, 2011). To renew your certification without retaking the exam, you must participate in continuing education (CE) activities and pay an annual maintenance fee of $25.00 ($75.00 for 3 years). To learn more about the certification renewal policy, see http://certification.comptia.org/getCertified/stayCertified.aspx.

CompTIA A+ 220-801 and 220-802 Exam Objectives

Table I-1 lists the objectives and the chapters where they are covered. Be sure to check http://certification.comptia.org/home.aspx for any updates to the objectives.

Table I-1 CompTIA A+ 220-801 and 220-802 Exam Objectives

Objective	Chapters
220-801	
1.0 PC Hardware	
1.1 Configure and apply BIOS settings.	1, 3
1.2 Differentiate between motherboard components, their purposes, and properties.	1, 2
1.3 Compare and contrast RAM types and features.	1, 5
1.4 Install and configure expansion cards.	7, 8
1.5 Install and configure storage devices and use appropriate media.	1, 12
1.6 Differentiate among various CPU types and features and select the appropriate cooling method.	1, 2
1.7 Compare and contrast various connection interfaces and explain their purpose.	1, 6, 7
1.8 Install an appropriate power supply based on a given scenario.	1, 4
1.9 Evaluate and select appropriate components for a custom configuration, to meet customer specifications or needs.	8
1.10 Given a scenario, evaluate types and features of display devices.	1, 7
1.11 Identify connector types and associated cables.	1, 6, 7
1.12 Install and configure various peripheral devices.	6, 8
2.0 Networking	
2.1 Identify types of network cables and connectors.	16
2.2 Categorize characteristics of connectors and cabling.	16

Table I-1 Continued

Objective	Chapters
2.3 Explain properties and characteristics of TCP/IP.	16
2.4 Explain common TCP and UDP ports, protocols, and their purpose.	16
2.5 Compare and contrast wireless networking standards and encryption types.	16
2.6 Install, configure, and deploy a SOHO wireless/wired router using appropriate settings.	16
2.7 Compare and contrast Internet connection types and features.	16
2.8 Identify various types of networks.	16
2.9 Compare and contrast network devices their functions and features.	16
2.10 Given a scenario, use appropriate networking tools.	16
3.0 Laptops	
3.1 Install and configure laptop hardware and components.	9
3.2 Compare and contrast the components within the display of a laptop.	9
3.3 Compare and contrast laptop features.	9
4.0 Printers	
4.1 Explain the differences between the various printer types and summarize the associated imaging process.	11
4.2 Given a scenario, install, and configure printers.	11
4.3 Given a scenario, perform printer maintenance.	11
5.0 Operational Procedures	
5.1 Given a scenario, use appropriate safety procedures.	18
5.2 Explain environmental impacts and the purpose of environmental controls.	4, 18
5.3 Given a scenario, demonstrate proper communication and professionalism.	18
5.4 Explain the fundamentals of dealing with prohibited content/activity.	18
220-802	
1.0 Operating Systems	
1.1 Compare and contrast the features and requirements of various Microsoft Operating Systems.	14
1.2 Given a scenario, install, and configure the operating system using the most appropriate method.	13
1.3 Given a scenario, use appropriate command line tools.	14
1.4 Given a scenario, use appropriate operating system features and tools.	13, 14
1.5 Given a scenario, use Control Panel utilities (the items are organized by “classic view/large icons” in Windows).	14

Objective	Chapters
1.6 Setup and configure Windows networking on a client/desktop.	16
1.7 Perform preventive maintenance procedures using appropriate tools.	15
1.8 Explain the differences among basic OS security settings.	17
1.9 Explain the basics of client-side virtualization.	14
2.0 Security	
2.1 Apply and use common prevention methods.	17
2.2 Compare and contrast common security threats.	17
2.3 Implement security best practices to secure a workstation.	17
2.4 Given a scenario, use the appropriate data destruction/disposal method.	17
2.5 Given a scenario, secure a SOHO wireless network.	17
2.6 Given a scenario, secure a SOHO wired network.	17
3.0 Mobile Devices	
3.1 Explain the basic features of mobile operating systems.	10
3.2 Establish basic network connectivity and configure email.	10
3.3 Compare and contrast methods for securing mobile devices.	10
3.4 Compare and contrast hardware differences in regards to tablets and laptops.	10
3.5 Execute and configure mobile device synchronization.	10
4.0 Troubleshooting	
4.1 Given a scenario, explain the troubleshooting theory.	1
4.2 Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU and power with appropriate tools.	1, 2, 3, 4, 5, 6
4.3 Given a scenario, troubleshoot hard drives and RAID arrays with appropriate tools.	1, 12
4.4 Given a scenario, troubleshoot common video and display issues.	7
4.5 Given a scenario, troubleshoot wired and wireless networks with appropriate tools.	1, 16
4.6 Given a scenario, troubleshoot operating system problems with appropriate tools.	15
4.7 Given a scenario, troubleshoot common security issues with appropriate tools and best practices.	17
4.8 Given a scenario, troubleshoot, and repair common laptop issues while adhering to the appropriate procedures.	9
4.9 Given a scenario, troubleshoot printers with appropriate tools.	1, 11

Pearson IT Certification Practice Test Engine and Questions on the Disc

The disc in the back of the book includes the Pearson IT Certification Practice Test engine—software that displays and grades a set of exam-realistic multiple-choice questions. Using the Pearson IT Certification Practice Test engine, you can either study by going through the questions in Study Mode or take a simulated exam that mimics real exam conditions.

The installation process requires two major steps: installing the software and then activating the exam. The disc in the back of this book has a recent copy of the Pearson IT Certification Practice Test engine. The practice exam—the database of exam questions—is not on the disc.

NOTE The cardboard disc case in the back of this book includes the disc and a piece of paper. The paper lists the activation code for the practice exam associated with this book. Do not lose the activation code. On the opposite side of the paper from the activation code is a unique, one-time use coupon code for the purchase of the Premium Edition eBook and Practice Test.

Install the Software from the Disc

The Pearson IT Certification Practice Test is a Windows-only desktop application. You can run it on a Mac using a Windows Virtual Machine, but it was built specifically for the PC platform. The minimum system requirements are

- Windows XP (SP3), Windows Vista (SP2), or Windows 7
- Microsoft .NET Framework 4.0 Client
- Microsoft SQL Server Compact 4.0
- Pentium class 1GHz processor (or equivalent)
- 512MB RAM
- 650MB disc space plus 50MB for each downloaded practice exam

The software installation process is pretty routine compared with other software installation processes. If you have already installed the Pearson IT Certification Practice Test software from another Pearson product, there is no need for you to reinstall the software. Simply launch the software on your desktop and proceed to activate the practice exam from this book by using the activation code included in the disc sleeve.

The following steps outline the installation process:

Step 1. Insert the disc into your PC.

Step 2. The software that automatically runs is the Pearson software to access and use all disc-based features, including the exam engine and the disc-only appendixes. From the main menu, click the option to **Install the Exam Engine**.

Step 3. Respond to windows prompts as with any typical software installation process.

The installation process gives you the option to activate your exam with the activation code supplied on the paper in the disc sleeve. This process requires that you establish a Pearson website login. You need this login to activate the exam, so please do register when prompted. If you already have a Pearson website login, there is no need to register again. Just use your existing login.

Activate and Download the Practice Exam

After the exam engine is installed, you should then activate the exam associated with this book (if you did not do so during the installation process) as follows:

Step 1. Start the Pearson IT Certification Practice Test software from the Windows **Start** menu or from your desktop shortcut icon.

Step 2. To activate and download the exam associated with this book, from the **My Products** or **Tools** tab, select the **Activate** button.

Step 3. At the next screen, enter the Activation Key from the paper inside the cardboard disc holder in the back of the book. When entered, click the **Activate** button.

Step 4. The activation process downloads the practice exam. Click **Next** and then click **Finish.**

After the activation process finishes, the **My Products** tab should list your new exam. If you do not see the exam, make sure you have selected the **My Products** tab on the menu. At this point, the software and practice exam are ready to use. Simply select the exam, and click the **Open Exam** button.

To update a particular exam you have already activated and downloaded, simply select the **Tools** tab, and select the **Update Products** button. Updating your exams will ensure you have the latest changes and updates to the exam data.

If you want to check for updates to the Pearson Cert Practice Test exam engine software, simply select the **Tools** tab, and select the **Update Application** button. This will ensure you are running the latest version of the software engine.

Activating Other Exams

The exam software installation process, and the registration process, must happen only once. Then, for each new exam, only a few steps are required. For instance, if you buy another new Pearson IT Certification Cert Guide or Cisco Press Official Cert Guide, extract the activation code from the disc sleeve in the back of that book—you don't even need the disc at this point. From there, all you need to do is start the exam engine (if not still up and running), and perform Steps 2–4 from the previous list.

Premium Edition

In addition to the two free practice exams provided on the disc, you can purchase two additional exams with expanded functionality directly from Pearson IT Certification. The Premium Edition eBook and Practice Test for this title contains two additional full practice exams as well as an eBook (in both PDF and ePub format). In addition, the Premium Edition title also has remediation for each question to the specific part of the eBook that relates to that question.

If you have purchased the print version of this title, you can purchase the Premium Edition at a deep discount. There is a coupon code in the disc sleeve that contains a one-time use code as well as instructions for where you can purchase the Premium Edition.

To view the premium edition product page, go to www.informit.com/title/978078978492.

This page intentionally left blank

This chapter covers the following subjects:

- **Power Supplies**—This section describes the device that transforms AC power from the wall outlet into DC power that your computer can use. It also describes the various form factors and voltage levels, and how to protect your power supply.
- **Troubleshooting Power Problems**—This section demonstrates how to troubleshoot complete failure and intermittent power supply problems that you might encounter.
- **Avoiding Power Supply Hazards**—This section has guidelines for avoiding shock and fire hazards when working with power supplies.
- **Power Protection Types**—In this section you learn about devices that can protect your computer from over and under voltage issues. These include surge protectors, uninterruptible power supplies, and line conditioners.
- **System Cooling**—This last section describes the various ways to cool your system, including fans and liquid cooling, and demonstrates how to monitor the system temperature.

This chapter covers **CompTIA A+ 220-801 objectives 1.8 and 5.2** and **CompTIA A+ 220-802 objective 4.2**.

CHAPTER 4

Power Supplies and System Cooling

Clean, well-planned power is imperative, from the AC outlet to the electrical protection equipment to the power supply. Many of the issues that you see concerning power are due to lack of protection or improper planning, and as such you will see several questions on the A+ exams regarding this subject.

In this chapter we delve into how power is conveyed to the computer, which power supply to select depending on your configuration and needs, how to install and troubleshoot power supplies, and how to cool the system.

Foundation Topics

Power Supplies

220-801

Objective:
220-801: 1.8

Power issues are largely ignored by most computer users, but a properly working power supply is the foundation to correct operation of the system. When the power supply stops working, the computer stops working, and when a power supply stops functioning properly—even slightly—all sorts of computer problems can take place. From unexpected system reboots to data corruption, from unrecognized bus-powered USB devices to system overheating, a bad power supply is bad news. The power supply is vital to the health of the computer. So, if your computer is acting "sick," you should test the power supply to see if it's the cause. To keep the power supply working properly, use surge suppression and battery backup (UPS) units.

Key Topic

The **power supply** is really misnamed: It is actually a power converter that changes high-voltage alternating current (**AC**) to low-voltage direct current (**DC**). There are lots of wire coils, capacitors, and other components inside the power supply that do the work, and during the conversion process, a great deal of heat is produced. Most power supplies include one or two fans to dissipate the heat created by the operation of the power supply; however, a few power supplies designed for silent operation use passive heat sink technology instead of fans. On power supplies that include fans, fans also help to cool the rest of the computer. Figure 4-1 shows a typical desktop computer's power supply.

Power Supply Ratings

Key Topic

Power supply capacity is rated in watts, and the more watts a power supply provides, the more devices it can safely power.

You can use the label attached to the power supply, shown in Figure 4-2, to determine its wattage rating and see important safety reminders.

Key Topic

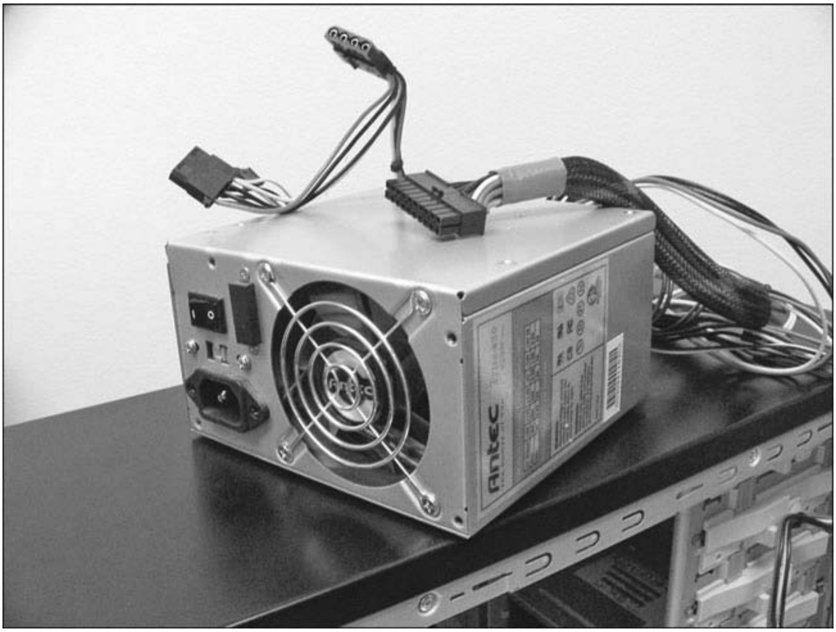
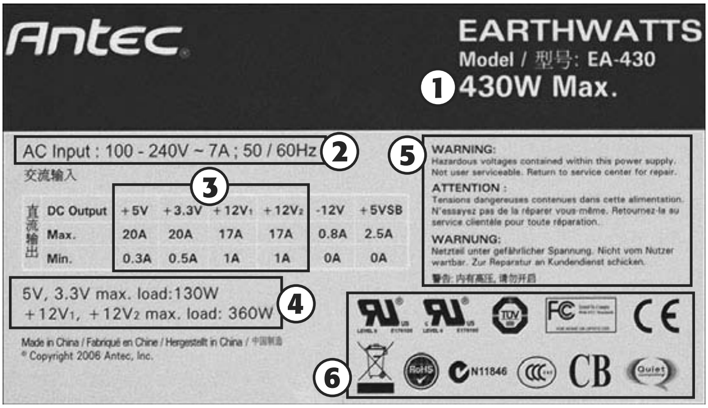


Figure 4-1 A typical ATX power supply.

NOTE The power supply shown in Figure 4-2 is a so-called "split rail" design with two separate 12V outputs ($+12V_1$ and $+12V_2$). This type of design is frequently used today to provide separate 12V power sources for processors (which reduce 12V power to the power level needed) and other devices such as PCI Express video cards, fans, and drives). Add the values together to get the total 12V output in amps (34A).

Typically, power supplies in recent tower-case (upright case) machines use 400-watt or larger power supplies, reflecting the greater number of drives and cards that can be installed in these computers. Power supplies used in slimline desktop computers have typical ratings of around 220–300 watts,. The power supply rating is found on the top or side of the power supply, along with safety rating information and amperage levels produced by the power supply's different DC outputs.

How can you tell whether a power supply meets minimum safety standards? Look for the appropriate safety certification mark for your country or locale. For example, in the U.S. and Canada, the backward UR logo is used to indicate the power supply has the UL and UL Canada safety certifications as a component (the familiar circled UL logo is used for finished products only).



1. Power supply rating
2. AC input voltage levels
3. DC output levels by type
4. +3.3V, +5V, and +12V maximum load
5. Hazard warnings
6. Product certifications

Figure 4-2 A typical power supply label.

CAUTION Power supplies that do not bear the UL or other certification marks should not be used, as their safety is unknown. For a visual guide to electrical and other safety certification marks in use around the world, visit the Standard Certification Marks page at www.technick.net/public/code/cp_dpage.php?aiocp_dp=guide_safetymarks.

Key Topic

Use the following methods to determine the wattage rating needed for a replacement power supply:

- Whip out your calculator and add up the wattage ratings for everything connected to your computer that uses the power supply, including the motherboard, processor, memory, cards, drives, and bus-powered USB devices. If the total wattage used exceeds 70% of the wattage rating of your power supply, you should upgrade to a larger power supply. Check the vendor spec sheets for wattage ratings.
- If you have amperage ratings instead of wattage ratings, multiply the amperage by the volts to determine wattage and then start adding. If a device uses two or three different voltage levels, be sure to carry out this calculation for each voltage level, and add up the figures to determine the wattage requirement for the device.
- Use an interactive power supply sizing tool such as the calculators provided by eXtreme Outervision (www.extreme.outervision.com) or PC Power and Cooling (www.pcpower.com).

Table 4-1 provides calculations for typical compact desktop and performance desktop systems.

Table 4-1 Calculating Power Supply Requirements

MicroATX System with Integrated Video		Full-Size ATX System with SLI (Dual Graphics Cards)	
Components	**Wattage**	**Components**	**Wattage**
AMD A8 3800 (4 core with in-core graphics and L2 cache)	65	Intel Core i7-3960X Extreme Edition (6 cores with L3 cache)	130
microATX motherboard	60	ATX motherboard	100
4GB RAM	60	8GB RAM	120
Rewritable DVD drive	30	Rewritable Blu-ray drive	30
SATA hard disk	20	SATA hard disk	20
Two case fans	6	Three case fans	9
CPU fan	3	CPU fan	3
Integrated graphics (in CPU)	—	High-end SLI video cards (2)	210 (105×2)
Estimated wattage	244	Estimated wattage	622
Minimum power supply size recommended (80% efficiency assumed)	350	Minimum power supply size recommended (80% efficiency assumed)	750

NOTE The 80 PLUS certification standard is an industry standard for evaluating power supply efficiency. 80 PLUS certified power supplies achieve 80% efficiency at up to 100% of rated load. The use of power supplies with 80 PLUS certification is assumed in Table 4-1. Higher standards (80 PLUS Bronze, Silver, Gold, and Platinum) achieve up to 89% efficiency at 100% of rated load on 115V power and up to 91% on 230V power. For more information, see the Ecova Plug Load Solutions website at http://www.plugloadsolutions.com/. For non-80 PLUS power supplies, assume 70% efficiency.

Multivoltage Power Supplies

Key Topic

Most power supplies are designed to handle two different voltage ranges:

- 110–120V/60Hz
- 220–240V/50Hz

Standard North American power is now 115–120V/60Hz-cycle AC (the previous standard was 110V). The power used in European and Asian countries is typically 230–240V/50Hz AC (previously 220V). Power supplies typically have a slider switch with two markings: 115 (for North American 110–120V/60HzAC) and 230 (for European and Asian 220–240V/50Hz AC). Figure 4-3 shows a slider switch set for correct North American voltage. If a power supply is set to the wrong input voltage, the system will not work. Setting a power supply for 230V with 110–120V current is harmless; however, feeding 220–240V into a power supply set for 115V will destroy the power supply, and possibly other onboard hardware.

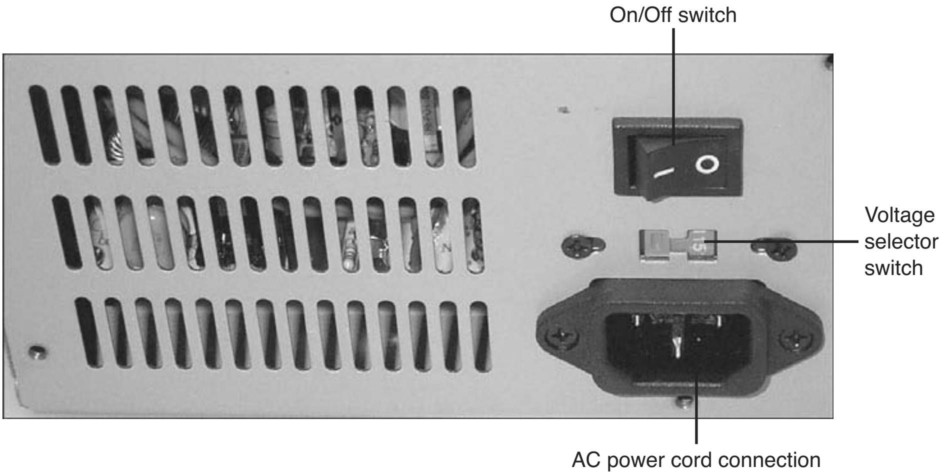


Figure 4-3 A typical power supply's sliding voltage switch set for correct North American voltage (115V). Slide it to 230V for use in Europe and Asia.

NOTE Note that some power supplies for desktop and notebook computers can automatically determine the correct voltage level and cycle rate. These are referred to as *autoswitching power supplies* and lack the voltage/cycle selection switch shown in Figure 4-3.

The on/off switch shown in Figure 4-3 controls the flow of current into the power supply. It is not the system power switch, which is located on the front of most recent systems and is connected to the motherboard. When you press the system power switch, the motherboard signals the power supply to provide power.

CAUTION Unless the power supply is disconnected from AC current or is turned off, a small amount of power can still be flowing through the system, even when it is not running. Do not install or remove components or perform other types of service to the inside of a PC unless you disconnect the AC power cord or turn off the power supply. Wait a few seconds afterward to ensure that the power is completely off. Some desktop motherboards have indicator lights that turn off when the power has completely drained from the system.

Power Supply Form Factors and Connectors

When you shop for a power supply, you also need to make sure it can connect to your motherboard. There are two major types of power connectors on motherboards:

- 20-pin, used by older motherboards in the ATX family
- 24-pin, used by recent ATX/BTX motherboards requiring the ATX12V 2.2 power supply standard

Some high-wattage power supplies with 20-pin connectors might also include a 20-pin to 24-pin adapter. Some 24-pin power supplies include a 24-pin to 20-pin connector.

Some motherboards use power supplies that feature several additional connectors to supply added power, as follows (see Figure 4-4):

- The four-wire square ATX12V connector provides additional 12V power to the motherboard; this connector is sometimes referred to as a "P4" or "Pentium 4" connector.
- Many recent high-end power supplies use the eight-wire EPS12V connector (see Figure 4-6) instead of the ATX12V power connector. Often, the EPS12V lead is split into two four-wire square connectors to be compatible with motherboards that use either ATX12V or EPS12V power leads.
- Some older motherboards use a six-wire AUX connector to provide additional power.

Figure 4-5 lists the pinouts for the 20-pin and 24-pin ATX power supply connectors shown in Figure 4-4.

Key Topic

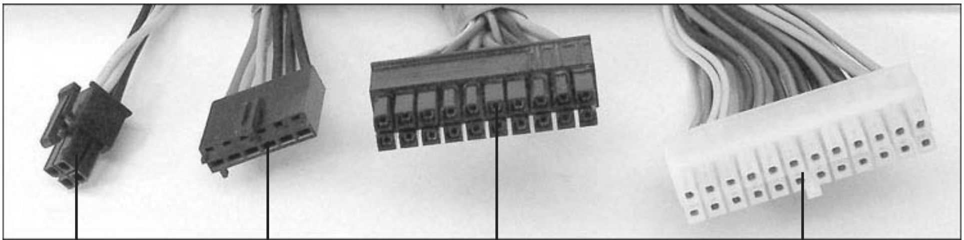


Figure 4-4 20-pin ATX and 24-pin ATX power connectors compared to four-pin ATX12V and six-wire AUX power connectors.

Key Topic

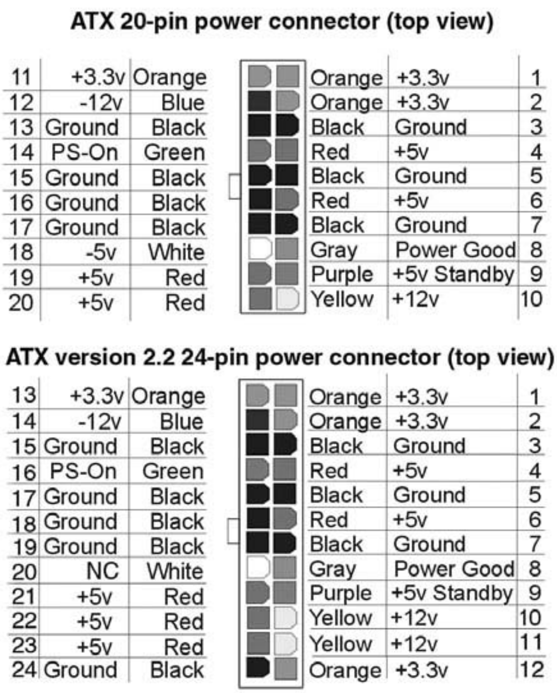


Figure 4-5 Pinout for standard ATX 20-pin and 24-pin power connectors.

The power supply also powers various peripherals, such as the following:

- PATA hard disks, CD and DVD optical drives, and case fans that do not plug into the motherboard use a four-pin Molex power connector.
- 3.5-inch floppy drives use a four-pin Berg power connector.
- Serial ATA (SATA) hard disks use an L-shaped 15-pin thinline power connector.
- High-performance PCI Express x16 video cards that require additional 12V power use a PCI Express six-pin or eight-pin power cable.

Figure 4-6 illustrates these power connectors.

Key Topic

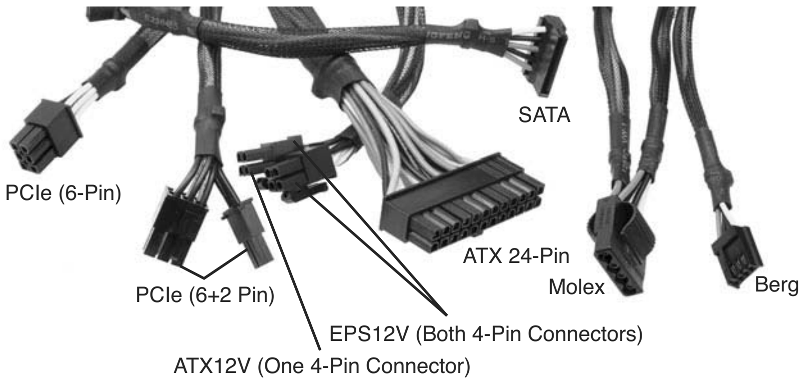


Figure 4-6 Power supply connectors for peripherals and modern motherboards.

If your power supply doesn't have enough connectors, you can add Y-splitters to divide one power lead into two, but these can short out and can also reduce your power supply's efficiency. You can also convert a standard Molex connector into an SATA or floppy drive power connector with the appropriate adapter.

Some power supplies (see Figure 4-7) use modular connections so that you can customize the power supply connections needed for your hardware.

CAUTION Many recent and older Dell desktop computers use proprietary versions of the 20-pin or 24-pin ATX power supply connectors. Dell's versions use a different pinout that routes voltages to different wires than in standard power supplies. Consequently, if you plug a standard power supply into a Dell PC that uses the proprietary version or use a regular motherboard as an upgrade for a model that has the proprietary power supply, stand by for smoke and fire! To determine whether a particular Dell computer model requires a proprietary power supply, check the PC Power and Cooling PSU recommendation for your Dell system at www.pcpower.com/Dell.html.

Figure 4-7 A modular power supply includes cables you can attach to customize support for your system's needs.

If your wattage calculations or your tests (covered later in this chapter) agree that it's time to replace the power supply, make sure the replacement meets the following criteria:

- Have the same power supply connectors and the same pinout as the original.
- Have the same form factor (shape, size, and switch location)
- Have the same or higher wattage rating; a higher wattage rating is highly desirable
- Support any special features required by your CPU, video card, and motherboard, such as SLI support (support for PCI Express connectors to power dual high-performance PCI Express x16 video cards), high levels of +12V power (ATX12V v2.2 4-pin or EPS12V 8-pin power connectors), and so on

TIP To ensure form factor connector compatibility, consider removing the old power supply and taking it with you if you plan to buy a replacement at retail. If you are buying a replacement online, measure the dimensions of your existing power supply to ensure that a new one will fit properly in the system.

Removing and Replacing the Power Supply

Installing a new power supply is one of the easier repairs to make. You don't need to fiddle with driver CDs or Windows Update to get the new one working. But, you do need to be fairly handy with a screwdriver or nut driver.

Typical power supplies are held in place by several screws that attach the power supply to the rear panel of the computer. The power supply also is supported by a shelf inside the case, and screws can secure the power supply to that shelf. To remove a power supply, follow these steps:

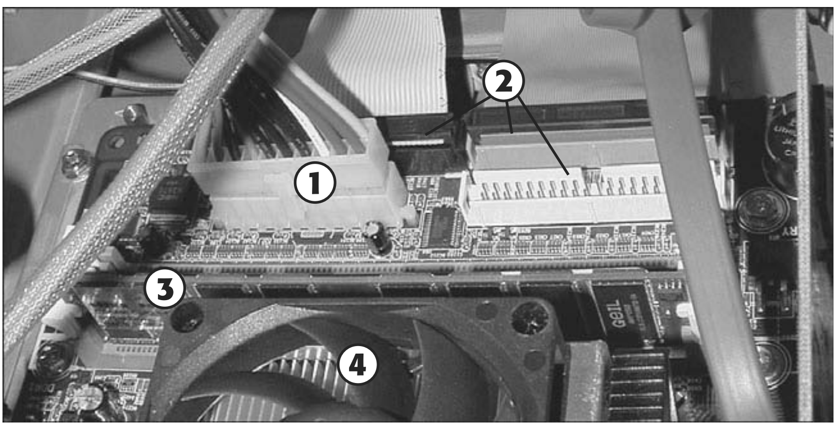
Key Topic

Step 1. Power down the computer. If the power supply has an on/off switch, turn it off as well.

Step 2. Disconnect the AC power cord from the computer.

Step 3. Open the case to expose the power supply, which might be as simple as removing the cover on a desktop unit or as involved as removing both side panels, front bezel, and case lid on a tower PC. Consult the documentation that came with your computer to determine how to expose the power supply for removal.

Step 4. Disconnect the existing power supply from the motherboard (see Figure 4-8). The catch securing the power supply connector must be released to permit the connector to be removed.



1. Catch securing power supply connector
2. PATA/IDE drive connectors
3. Memory module
4. Active heat sink for processor

Figure 4-8 Disconnecting the power supply from the motherboard.

Step 5. Disconnect all other power supply leads to the motherboard (fan monitors, ATX12V, EPS12V, AUX).

Step 6. Disconnect the power supply from all drives and add-on cards.

Step 7. Disconnect the power supply from all fans.

Step 8. Remove the power supply screws from the rear of the computer case (see Figure 4-9).

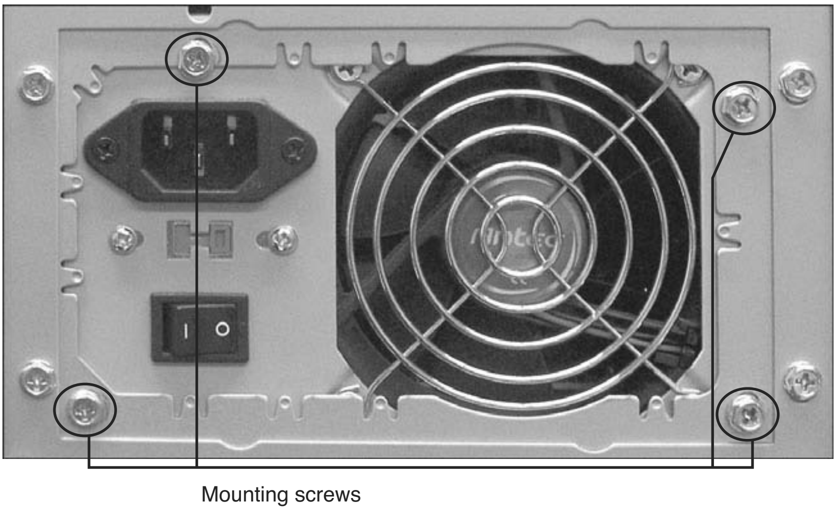


Figure 4-9 Removing the mounting screws from a typical power supply.

Step 9. Remove any screws holding the power supply in place inside the case. (Your PC might not use these additional screws.)

Step 10. Lift or slide the power supply out of the case.

Before installing the replacement power supply, compare it to the original, making sure the form factor, motherboard power connectors, and switch position match the original. If the new power supply has a fan on top (as well as the typical rear-mounted fan), make sure the fan faces the inside of the case.

To install the replacement power supply, follow these steps:

Step 1. Lift or slide the power supply into the case.

Step 2. Attach the power supply to the shelf with screws (if required).

Step 3. Slide the power supply to the rear of the computer case; line up the holes in the unit carefully with the holes in the outside of the case.

Step 4. Connect the power supply to all fans, drives, add-on cards, and motherboard.

Step 5. Check the voltage setting on the power supply. Change it to the correct voltage for your location if necessary.

Step 6. Connect the AC power cord to the new power supply.

Step 7. Turn on the computer.

Step 8. Start the system normally to verify correct operation, and then run the normal shutdown procedure for the operating system. If necessary, turn off the system with the front power switch only.

Step 9. Close the case and secure it.

Troubleshooting Power Supplies

220-802

Objective:
220-802: 4.2

Problems with power supplies can cause a variety of symptoms, including

- Overheating
- Spontaneous rebooting
- Intermittent device failure (particularly of bus-powered USB devices)
- Loud noises

What can cause these symptoms, and how can you solve the problems behind the symptoms?

Overloaded Power Supplies—Symptoms and Solutions

Key Topic

What happens if you connect devices that require more wattage than a power supply can provide? This is a big problem called an *overload*. An overloaded power supply has three major symptoms:

- Overheating
- Spontaneous rebooting (cold boot with memory test) due to incorrect voltage on the Power Good line running from the power supply to the motherboard

- Intermittent failures of USB bus-powered devices (mice, keyboard, USB flash drives, portable USB hard disks) because these devices draw power from the system's power supply via the USB port

Here's a good rule of thumb: If your system starts spontaneously rebooting and you don't see a blue screen (STOP) error, replace the power supply as soon as possible. However, power supply overheating can have multiple causes; follow the steps listed in the section "Overheating," later in this chapter, before replacing an overheated power supply.

To determine whether Power Good or other motherboard voltage levels are within limits, perform the measurements listed in the section "Testing Power Supplies and Other Devices with a Multimeter," later in this chapter.

Loud Noises from the Power Supply

Key Topic

Computers usually run quietly, but if you hear loud noises coming from the power supply, it's a sure sign of problems. A whirring, rattling, or thumping noise while the system is on usually indicates a fan failure. If a fan built in to a component such as a heat sink or power supply is failing, replace the component immediately.

CAUTION Should you try to replace a standard power supply fan? No. Because the power supply is a sealed unit, you would need to remove the cover from most power supplies to gain access to the fan. The capacitors inside a power supply retain potentially *lethal* electrical charges. Instead, scrap the power supply and replace it with a higher-rated unit. Refer to the section "Removing and Replacing the Power Supply," earlier in the chapter.

A power supply that makes a loud bang, followed by a system crash, has had an onboard capacitor blow up. The easiest way to diagnose this is to smell the power supply after turning it off and disconnecting it from AC power. If you can smell a burnt odor with a chemical overtone to it coming from the power supply's outside vent, your power supply has died. This odor can linger for weeks. Sadly, when a power supply blows up like this, it can also destroy the motherboard, bus-powered USB devices connected to the computer, and other components.

Key Topic

Finding Solutions to a "Dead" System

A dead system that gives no signs of life when turned on can be caused by the following:

- Defects in AC power to the system
- Power supply failure or misconfiguration
- Temporary short circuits in internal or external components
- Power supply or other component failure

With four suspects, it's time to play detective. Use the procedure outlined next to find the actual cause of a dead system. If one of the test procedures in the following list corrects the problem, the item that was changed is the cause of the problem. Power supplies have a built-in safety feature that shuts down the unit immediately in case of short circuit.

Key Topic

The following steps are designed to determine whether the power problem is caused by a short circuit or another problem:

Step 1. Smell the power supply's outside vent. If you can detect a burnt odor, the power supply has failed (see previous section).

Step 2. Check the AC power to the system; a loose or disconnected power cord, a disconnected surge protector, a surge protector that has been turned off, or a dead AC wall socket will prevent a system from receiving power. If the wall socket has no power, reset the circuit breaker in the electrical service box for the location.

Step 3. Check the AC voltage switch on the power supply; it should be set to 115V for North America. Turn off the power, reset the switch, and restart the system if the switch was set to 230V. Note that many desktop computer power supplies no longer require a switch selection because they are autoranging.

CAUTION If your area uses 230V and the power supply is set to 115V, you need a new power supply and possibly other components, because they've been damaged or destroyed by 100% overvoltage.

Step 4. If the system uses a PS/2 mouse or keyboard, check the connectors; a loose keyboard connector could cause a short circuit.

Step 5. Turn off the system, disconnect power, and open the system. Verify that the power leads are properly connected to the motherboard. Connect loose power leads, reconnect power, and restart the computer.

Step 6. Check for loose screws or other components such as loose slot covers, modem speakers, or other metal items that can cause a short circuit. Correct them and retest.

Step 7. Remove all expansion cards and disconnect power to all drives; restart the system and use a multimeter to test power to the motherboard per Table 4-3.

Step 8. If the power tests within accepted limits with all peripherals disconnected, reinstall one card at a time and check the power. If the power tests within accepted limits, reattach one drive at a time and check the power.

Step 9. If a defective card or drive has a dead short, reattaching the defective card or drive should stop the system immediately upon power-up. Replace the card or drive and retest.

Step 10. Check the Power Good line at the power supply motherboard connector with a multimeter.

It's a long list, but chances are you will track down the offending component before you reach the end of it.

Overheating

Key Topic

Got an overheated power supply? Not sure? If you touch the power supply case and it's too hot to touch, it's overheated. Overheated power supplies can cause system failure and possible component damage, due to any of the following causes:

- Overloading
- Fan failure
- Inadequate airflow outside the system
- Inadequate airflow inside the system
- Dirt and dust

Use the following sections to figure out the possible effects of these problems in any given situation.

Overloading

An overloaded power supply is caused by connecting devices that draw more power (in watts) than the power supply is designed to handle. As you add more card-based devices to expansion slots, use more bus-powered USB and IEEE-1394 drives and devices, and install more internal drives in a system, the odds of having an overloaded power supply increase.

If a power supply fails or overheats, check the causes listed in the following sections before determining whether you should replace the power supply. If you determine that you should replace the power supply, purchase a unit that has a higher wattage rating.

Fan Failure

The fan(s) inside the power supply cool it and are partly responsible for cooling the rest of the computer. If they fail, the power supply and the entire computer are at risk of damage. Fans also might stop turning as a symptom of other power problems.

A fan that stops immediately after the power comes on usually indicates incorrect input voltage or a short circuit. If you turn off the system and turn it back on again under these conditions, the fan will stop each time.

To determine whether a fan has failed, listen to the unit; it should make less noise if the fan has failed. You can also see the fan blades spinning rapidly on a power supply fan that is working correctly. If the blades aren't turning or are turning very slowly, the fan has failed or is too clogged with dust to operate correctly.

To determine whether case fans have failed, look at them through the front or rear of the system, or, if they are connected to the motherboard, use the system monitoring feature in the system BIOS to check fan speed. Figure 4-10 illustrates a typical example.

NOTE If a fan has failed because of a short circuit or incorrect input voltage, you will not see any picture onscreen because the system cannot operate.

If the system starts normally but the fan stops turning later, this indicates a true fan failure instead of a power problem.

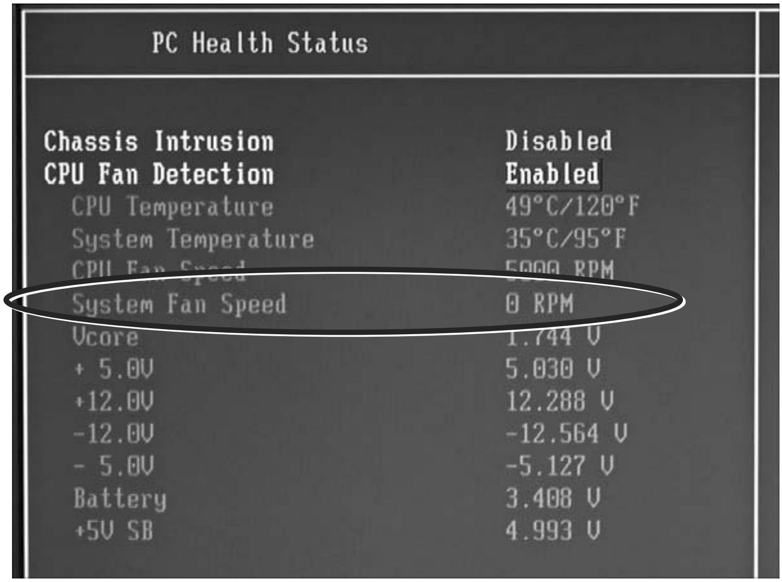


Figure 4-10 The system fan (case fan) has either failed or was never connected to the motherboard power/monitor header.

Inadequate Airflow Outside the System

The power supply's capability to cool the system depends in part on free airflow space outside the system. If the computer is kept in a confined area (such as a closet or security cabinet) without adequate ventilation, power supply failures due to overheating are likely.

Even systems in ordinary office environments can have airflow problems; make sure that several inches of free air space exist behind the fan outputs for any computer.

Inadequate Airflow Inside the System

As you have seen in previous chapters, the interior of the typical computer is a messy place. Wide ribbon cables used for some types of drives, drive power cables, and expansion cards create small air dams that block airflow between the heat sources—such as the motherboard, CPU, drives, and memory modules—and the fans in the power supply. Figure 4-11 illustrates a typical system with a lot of cable clutter that can interfere with airflow.

Figure 4-11 A cluttered system with plenty of unsecured cables to block airflow.

You can do the following to improve airflow inside the computer:

- Use cable ties to secure excess ribbon cable and power connectors out of the way of the fans and the power supply.
- Replace any missing slot covers.
- Make sure that auxiliary case fans, chipset fans, and CPU fans are working correctly.
- Use SATA drives in place of PATA drives. SATA drives use narrow data cables.

Figure 4-12 illustrates a different system that uses cable management (cable ties, bundling cables between the drive bays and outer case wall, and routing behind the motherboard) to improve airflow.

For more information about cooling issues, see the section “System Cooling,” later in this chapter for details.

Figure 4-12 A system with good airflow due to intelligent cable management.

Dirt and Dust

Most power supplies, except for a few of the early ATX power supplies, use a cooling technique called *negative pressure*; in other words, the power supply fan works like a weak vacuum cleaner, pulling air through vents in the case, past the components, and out through the fan. Vacuum cleaners are used to remove dust, dirt, cat hairs, and so on from living rooms and offices, and even the power supply's weak impression of a vacuum cleaner works the same way.

When you open a system for any kind of maintenance, look for the following:

- Dirt, dust, hair, and gunk clogging the case vents
- A thin layer of dust on the motherboard and expansion slots
- Dirt and dust on the power supply vent and fans

Yuck! You never know what you'll find inside a PC that hasn't been cleaned out for a year or two. So how can you get rid of the dust and gunk? You can use either a vacuum cleaner specially designed for computer use or compressed air to remove dirt and dust from inside the system. If you use compressed air, be sure to spread newspapers around the system to catch the dirt and dust. If possible, remove the computer from the computer room so the dust is not spread to other equipment.

Fans Turn But System Doesn't Start

Fans connected directly to the power supply will run as soon as the system is turned on, but if the system doesn't start up, this could indicate a variety of problems. Check the following:

- Make sure the main ATX and 12V ATX or EPS power leads are securely connected to the appropriate sockets.
- Make sure the CPU and memory modules are securely installed in the appropriate sockets.

Testing Power Supplies and Other Devices with a Multimeter

How can you find out that a defective power supply is really defective? How can you make sure that a cable has the right pinouts? Use a multimeter. A **multimeter** is one of the most flexible diagnostic tools around. It is covered in this chapter because of its usefulness in testing power supplies, but it also can be used to test coaxial, serial, and parallel cables, as well as fuses, resistors, and batteries.

Multimeters are designed to perform many different types of electrical tests, including the following:

- DC voltage and polarity
- AC voltage and polarity
- Resistance (Ohms)
- Diodes
- Continuity
- Amperage

All multimeters are equipped with red and black test leads. When used for voltage tests, the red is attached to the power source to be measured and the black is attached to ground.

Multimeters use two different readout styles: digital and analog. Digital multimeters are usually *autoranging*, which means they automatically adjust to the correct range for the test selected and the voltage present. Analog multimeters, or non–autoranging digital meters, must be set manually to the correct range and can be damaged more easily by overvoltage. Figure 4-13 compares typical analog and digital multimeters.

Figure 4-13 Typical analog (left) and digital (right) multimeters. Photos courtesy of Colacino Electric Supply, Newark, NJ.

Key Topic

Multimeters are designed to perform tests in two ways: in series and in parallel. Most tests are performed in parallel mode, in which the multimeter is not part of the circuit but runs parallel to it. On the other hand, amperage tests require that the multimeter be part of the circuit, so these tests are performed in series mode. Many low-cost multimeters do not include the ammeter feature for testing amperage (current), but you might be able to add it as an option.

Figure 4-14 shows a typical parallel mode test (DC voltage for a motherboard CMOS battery) and the current (amperage) test, which is a serial-mode test.

Table 4-2 summarizes the tests you can perform with a multimeter.

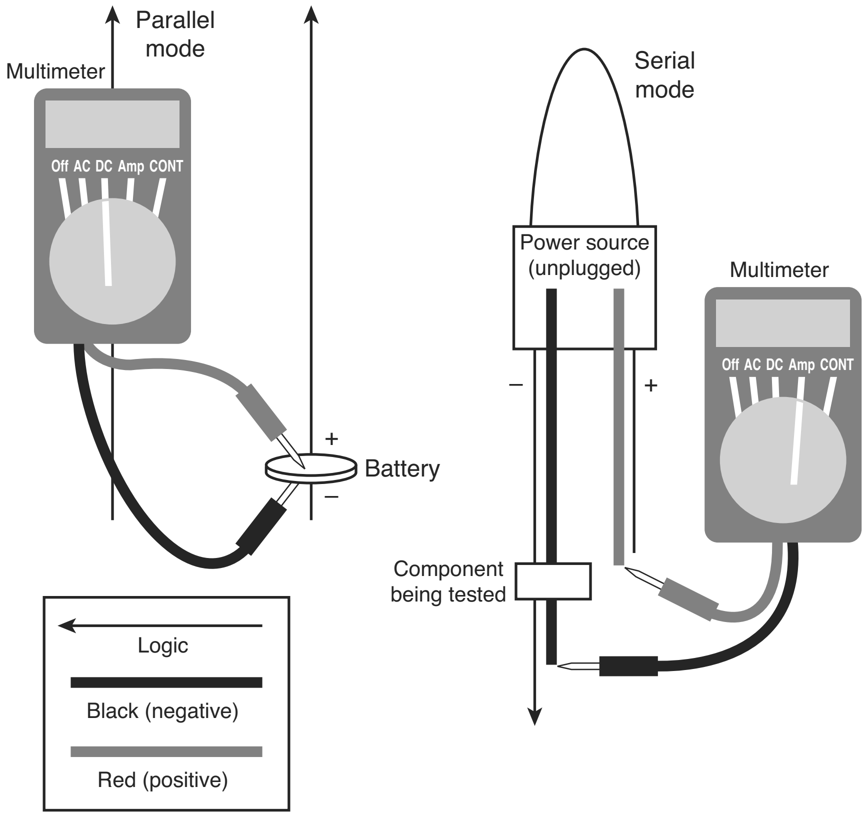


Figure 4-14 A parallel-mode (DC current) test setup (left) and an amperage (current) serial-mode test setup (right).

Table 4-2 Using a Multimeter

Test to Perform	Multimeter Setting	Probe Positions	Procedure
AC voltage (wall outlet)	AC	Red to hot, black to ground.	Read voltage from meter; should be near 115V in North America.
DC voltage (power supply outputs to motherboard, drives, batteries)	DC	Red to hot, black to ground.	Read voltage from meter; compare to default values.

Table 4-2 Continued

Test to Perform	Multimeter Setting	Probe Positions	Procedure
Continuity (cables, fuses)	CONT	Red to lead at one end of cable; black to corresponding lead at other end.	No CONT signal indicates bad cable or bad fuse.
		For a straight-through cable, check the same pin at each end. For other types of cables, consult a cable pinout to select the correct leads.	Double-check leads and retest to be sure.
Resistance (Ohms)	Ohms	Connect one lead to each end of resistor.	Check reading; compare to rating for resistor.
			A fuse should have no resistance.
Amperage (Ammeter)	Ammeter	Red probe to positive lead of circuit (power disconnected!); black lead to negative lead running through component to be tested.	Check reading; compare to rating for component tested.

You can use a multimeter to find out whether a power supply is properly converting AC power to DC power. Here's how: Measure the DC power going from the power supply to the motherboard. A power supply that does not meet the measurement standards listed in Table 4-3 should be replaced.

If the system monitor functions in the system BIOS do not display voltage levels (refer to Figure 4-10 for an example of a system that does display voltage levels in the BIOS), you can take the voltage measurements directly from the power supply connection to the motherboard. Both 20-pin and 24-pin P1 (ATX) power connectors are designed to be back-probed as shown in Figure 4-15; you can run the red probe through the top of the power connector to take a reading (the black probe uses the power supply enclosure or metal case frame for ground). Some motherboards bring these same voltage levels to a more convenient location on the motherboard for testing.

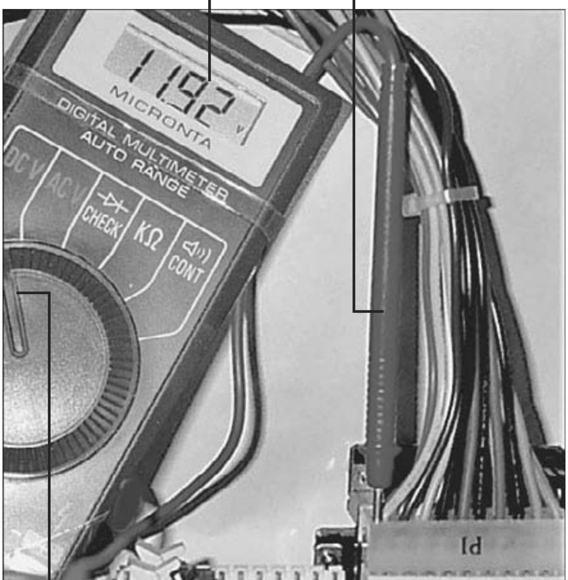
Key Topic

Table 4-3 Acceptable Voltage Levels

Rated DC Volts	Acceptable Range
+5.0	+4.8–5.2
-5.0	-4.8–5.2
-12.0	-11.4–12.6
+12.0	+11.4–12.6
+3.3	+3.14–3.5
Power Good	+3.0–6.0

Red probe from multimeter back-probing +12V line

DC voltage readout



Multimeter's mode selector switch set to DV voltage

Figure 4-15 Testing the +12V line on an ATX power supply. The voltage level indicated (+11.92V) is well within limits.

If a power supply fails any of these measurements, replace it and retest the new unit.

Avoiding Power Supply Hazards

220-801

Objective:
220-801: 5.2

To avoid shock and fire hazards when working with power supplies, follow these important guidelines:

Key Topic

- **Never disassemble a power supply or push metal tools through the openings in the case**—Long after you shut off the system, the capacitors inside the power supply retain potentially fatal voltage levels. If you want to see the interior of a power supply safely, check the websites of leading power supply vendors such as PC Power and Cooling.
- **If you are replacing the power supply in a Dell desktop computer, determine whether the computer uses a standard ATX or Dell proprietary ATX power supply**—Many Dell computers built from September 1998 to the present use a nonstandard version of the ATX power supply with a different pinout for the power connector. Install a standard power supply on a system built to use a Dell proprietary model, or upgrade from a Dell motherboard that uses the Dell proprietary ATX design to a standard motherboard, and you can literally cause a power supply and system fire!

NOTE The proprietary Dell version of the 20-pin ATX (P1) connector has no 3.3V (orange) lines, and its Power Good (gray wire) line is pin 5, not pin 8 as with a standard ATX power supply. The 3.3V (orange) wires are routed to the 6-pin Dell proprietary auxiliary connector. The proprietary Dell version of the 24-pin ATX (P1) connector also uses pin 5 for Power Good and provides 3.3V power (blue/white) through pins 11, 12, and 23, rather than through 1, 2, 12, and 13 as with a standard 24-pin ATX power supply. Make sure you buy a power supply made specifically for your Dell model.

- **Always use a properly wired and grounded outlet for your computer and its peripherals**—You can use a plug-in wiring tester to quickly determine whether a three-prong outlet is properly wired; signal lights on the tester indicate the outlet's status (see Figure 4-16).

Figure 4-16 An outlet tester like this one can find wiring problems quickly. This outlet is wired correctly.

Power Protection Types

220-801

Objective:
220-801: 5.2

Question. How well can a power supply work if it has poor-quality AC power to work with?

Answer. Not very well. Because computers and many popular computer peripherals run on DC power that has been converted from AC power, it's essential to make sure that proper levels of AC power flow to the computer and its peripherals. There are four problems you might run into:

- Overvoltages (spikes and surges)
- Undervoltages (brownouts)
- Power failure (blackouts)
- Noisy power (interference)

Extremely high levels of transient or sustained overvoltages can damage the power supply of the computer and peripherals, and voltage that is significantly lower than required will cause the computer and peripherals to shut down. Shutdowns happen immediately when all power fails. A fourth problem with power is interference; "noisy" electrical power can cause subtle damage, and all four types of problems put the most valuable property of any computer, the data stored on the computer, at risk. Protect your computer's power supply and other components with appropriate devices:

- Surge suppressors, which are also referred to as surge protectors
- Battery backup systems, which are also referred to as uninterruptible power supply (UPS) or standby power supply (SPS) systems
- Power conditioning devices

Surge Suppressors

Key Topic

Stop that surge! While properly designed **surge suppressors** can prevent power surges (chronic overvoltage) and spikes (brief extremely high voltage) from damaging your computer, low-cost ones are often useless because they lack sufficient components to absorb dangerous surges. Surge suppressors range in price from under $10 to close to $100 per unit.

Both spikes and surges are overvoltages: voltage levels higher than the normal voltage levels that come out of the wall socket. *Spikes* are momentary overvoltages, whereas surges last longer. Both can damage or destroy equipment and can come through data lines (such as RJ-11 phone or RJ-45 network cables) as well as through power lines. In other words, if you think of your PC as a house, spikes and surges can come in through the back door or the garage as well as through the front door. Better "lock" (protect) all the doors. Many vendors sell data-line surge suppressors.

How can you tell the real surge suppressors from the phonies? Check for a TVSS (transient voltage surge suppressor) rating on the unit. Multi-outlet power strips do not have a TVSS rating.

Beyond the TVSS rating, look for the following features to be useful in preventing power problems:

- A low TVSS let-through voltage level (400V AC or less). This might seem high compared to the 115V standard, but power supplies have been tested to handle up to 800V AC themselves without damage.
- A covered-equipment warranty that includes lightning strikes (one of the biggest causes of surges and spikes).
- A high Joule rating. Joules measure electrical energy, and surge suppressors with higher Joule ratings can dissipate greater levels of surges or spikes.
- Fusing that prevents fatal surges from getting through.
- Protection for data cables such as telephone/fax (RJ-11), network (RJ-45), or coaxial (RG6).
- EMI/RFI noise filtration (a form of line conditioning).
- Site fault wiring indicator (no ground, reversed polarity warnings).
- Fast response time to surges. If the surge suppressor doesn't clamp fast enough, the surge can get through.
- Protection against surges on hot, neutral, and ground lines.

If you use surge protectors with these features, you will minimize power problems. The site-fault wiring indicator will alert you to wiring problems that can negate grounding and can cause serious damage in ordinary use.

A surge suppressor that meets the UL 1449 or ANSI/IEEE C62.41 Category A (formerly IEEE 587 Category A) standards provides protection for your equipment. You might need to check with the vendor to determine whether a particular unit meets one of these standards.

NOTE To learn more about UL 1449 and the other UL standards it incorporates, see http://ulstandardsinfonet.ul.com/scopes/scopes.asp?fn=1449.html.

CAUTION High-quality surge protectors require grounding. If you plug them into an ungrounded electrical outlet, they don't work properly. The two- to three-prong adapter you use to enable grounded equipment to plug into an ungrounded outlet is designed to be attached to a ground such as a metal water pipe (that's what the metal loop on the adapter is for). If you can't ground the adapter, don't use a computer or other electronic device with it. If you do, sooner or later you'll be sorry.

Battery Backup Units (UPS and SPS)

A UPS is another name for a **battery backup** unit. A UPS provides emergency power when a power failure strikes (a blackout) or when power falls below minimum levels (a brownout).

Key Topic

There are two different types of UPS systems: true UPS and SPS systems. A true UPS runs your computer from its battery at all times, isolating the computer and monitor from AC power. There is no switchover time with a true UPS when AC power fails because the battery is already running the computer. A true UPS inherently provides power conditioning (preventing spikes, surges, and brownouts from reaching the computer) because the computer receives only battery power, not the AC power coming from the wall outlet. True UPS units are sometimes referred to as line-interactive battery backup units because the battery backup unit interacts with the AC line, rather than the AC line going directly to the computer and other components.

An SPS is also referred to as a UPS, but its design is quite different. Its battery is used only when AC power fails. A momentary gap in power (about 1ms or less) occurs between the loss of AC power and the start of standby battery power; however, this switchover time is far faster than is required to avoid system shutdown because computers can coast for several milliseconds before shutting down. SPS-type battery backup units are far less expensive than true UPSs but work just as well as true UPSs when properly equipped with power-conditioning features.

NOTE In the rest of this section, the term *UPS* refers to both true UPS or SPS units except as noted, because most backup units on the market technically are SPS but are called UPS units by their vendors. Make sure you understand the differences between these units for the exam.

Battery backup units can be distinguished from each other by differences in the following:

- **Runtimes**—The amount of time a computer will keep running on power from the UPS. A longer runtime unit uses a bigger battery and usually costs more than a unit with a shorter runtime. Fifteen minutes is a minimum recommendation for a UPS for an individual workstation; much larger systems are recommended for servers that might need to complete a lengthy shutdown procedure.
- **Network support**—Battery backup units made for use on networks are shipped with software that broadcasts a message to users about a server shutdown so that users can save open files and close open applications and then shuts down the server automatically before the battery runs down.

- **Automatic shutdown**—Some low-cost UPS units lack this feature, but it is essential for servers or other unattended units. The automatic shutdown feature requires an available USB (or RS-232 serial) port and appropriate software from the UPS maker. If you change operating systems, you need to update the software for your UPS to be supported by the new operating system.
- **Surge suppression features**—Virtually all UPS units today have integrated surge suppression, but the efficiency of integrated surge suppression can vary as much as separate units. Check for UL-1449 and ANSI/IEEE C62.41 Category A ratings to find reliable surge suppression in UPS units.

Figure 4-17 illustrates the rear of a typical UPS unit.

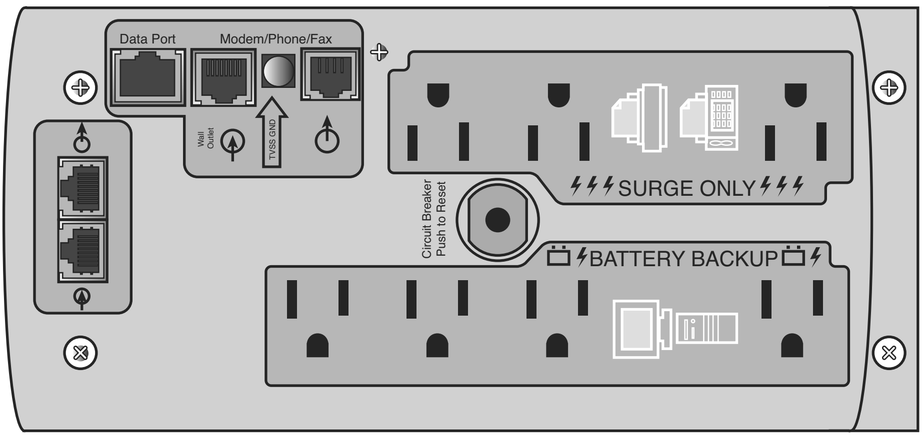


Figure 4-17 A typical UPS with integrated surge suppression for printers and other AC powered devices, 10/100/1000 Ethernet (including VoIP), and conventional telephony devices.

> **NOTE** Always plug a UPS directly into a wall outlet, not into a power strip or surge suppressor.

Buying the Correct-Sized Battery Backup System

Battery backups can't run forever. But then, they're not supposed to. This section describes how you can make sure you get enough time to save your files and shut down your computer. UPS units are rated in VA (volt-amps), and their manufacturers have interactive buying guides you can use online or download to help you select a model with adequate capacity. If you use a UPS with an inadequate VA rating for your equipment, your runtime will be substantially shorter than it should be.

Here's how to do the math: You can calculate the correct VA rating for your equipment by adding up the wattage ratings of your computer and monitor and multiplying the result by 1.4. If your equipment is rated in amperage (amps), multiply the amp rating by 120 (volts) to get the VA rating.

For example, my computer has a 450W power supply, which would require a 630VA-rated UPS (450×1.4) and a 17-inch monitor that is rated in amps, not watts. The monitor draws 0.9A, which would require a 108VA-rated UPS (0.9×120). Add the VA ratings together, and my computer needs a 750VA-rated battery backup unit or larger. Specifying a UPS with a VA rating at least twice what is required by the equipment attached to the UPS (for example, a 1500VA or higher rating, based on a minimum requirement of 750VA) will greatly improve the runtime of the battery.

In this example, a typical 750VA battery backup unit would provide about 5 minutes of runtime when used with my equipment. However, if I used a 1500VA battery backup, I could increase my runtime to more than 15 minutes because my equipment would use only about half the rated capacity of the UPS unit.

If you need a more precise calculation, for example, if you will also power an additional monitor or other external device, use the interactive sizing guides provided by battery backup vendors, such as American Power Conversion (www.apc.com).

CAUTION You should not attach laser printers to the battery-backup outlets on a UPS because their high current draw will cause the runtime of the battery to be very short. If the UPS has some outlets that provide surge protection only, you can use those outlets for a laser printer. In most cases, only the computer and monitor need to be attached to the UPS. However, inkjet printers, external modems, and external USB or FireWire hard disks have low current draw and can be attached to the UPS with little reduction in runtime.

Power-Conditioning Devices

Although power supplies are designed to work with voltages that do not exactly meet the 115V or 230V standards, power that is substantially higher or lower than what the computer is designed for can damage the system. Electrical noise on the power line, even with power at the correct voltage, also causes problems because it disrupts the correct sinewave alternating-current pattern the computer, monitor, and other devices are designed to use.

Better-quality surge protectors often provide power filtration to handle electromagnetic interference (EMI)/radio frequency interference (RFI) noise problems from laser printers and other devices that generate a lot of electrical interference.

However, to deal with voltage that is too high or too low, you need a true power conditioner.

Key Topic

Power-conditioning units take substandard or overstandard power levels and adjust them to the correct range needed by your equipment. Some units also include high-quality surge protection features.

To determine whether you need a power-conditioning unit, you can contact your local electric utility company to see whether it loans or rents power-monitoring devices. Alternatively, you can rent them from power consultants. These units track power level and quality over a set period of time (such as overnight or longer) and provide reports to help you see the overall quality of power on a given line.

Moving surge- and interference-causing devices such as microwaves, vacuum cleaners, refrigerators, freezers, and furnaces to circuits away from the computer circuits helps minimize power problems. However, in older buildings, or during times of peak demand, power conditioning might still be necessary. A true (line-interactive) UPS provides built-in power conditioning by its very nature (see the previous discussion).

System Cooling

220-802

Objective:
220-802: 4.2

Today's computers often run much hotter than systems of a few years ago, so it's important to understand how to keep the hottest-running components running cooler. The following sections discuss the components that are most in need of cooling and how to cool them (processor cooling is discussed in Chapter 2, "Motherboards and Processors").

Northbridge and Southbridge Chips and Voltage Regulators

Motherboards use a one-chip or two-chip chipset (also referred to as northbridge and southbridge chips) to route data to and from the processor. The northbridge or Memory Controller Hub (MCH) chip, because it carries high-speed data such as memory and video to and from the processor, becomes hot during operation, and, if the component overheats and is damaged, the entire motherboard must be replaced. For this reason, most motherboards feature some type of cooler for the northbridge chip.

Although the southbridge or I/O Controller Hub (ICH) chip carries lower-speed traffic, such as hard disk, audio, and network traffic, it can also become overheated. As a result, most recent motherboards also feature cooling for the southbridge chip. Some chipsets combine both functions into a single chip, which also requires cooling.

Key Topic

Three methods have been used for cooling the motherboard chipset. Passive heat sinks attached directly to the chipset chips are inexpensive but do not provide sufficient cooling for high-performance systems. Active heat sinks provide better cooling than passive heat sinks, but low-quality sleeve-bearing fans often used in these coolers can cause premature fan failure and lead to overheating. The latest trend in chipset and motherboard cooling uses heat pipes, which draw heat away from the chipset or other high-temperature components, such as the voltage regulator for CPU power, and dissipates it through high-performance, very large passive heat sinks located away from the chipset itself. While you can add other types of coolers to chipset chips, heat pipes are factory-installed.

Figure 4-18 illustrates passive and active heat sinks for northbridge and southbridge chips.

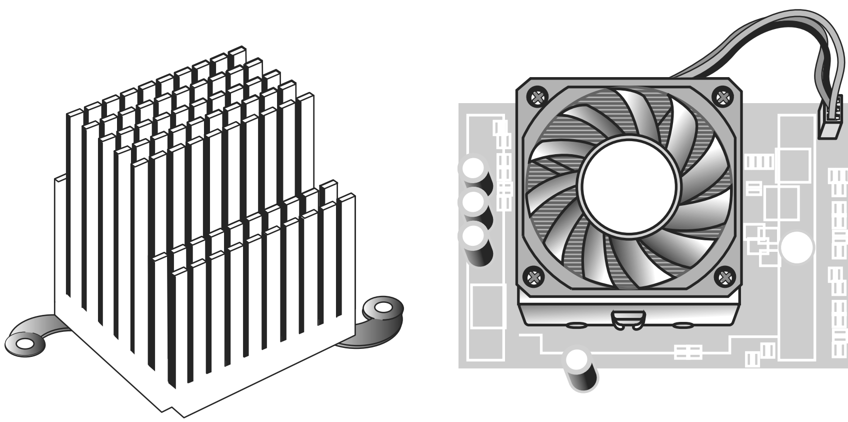


Figure 4-18 Passive and active heat sinks for chipsets.

Figure 4-19 illustrates a motherboard that uses heat pipes for component cooling.

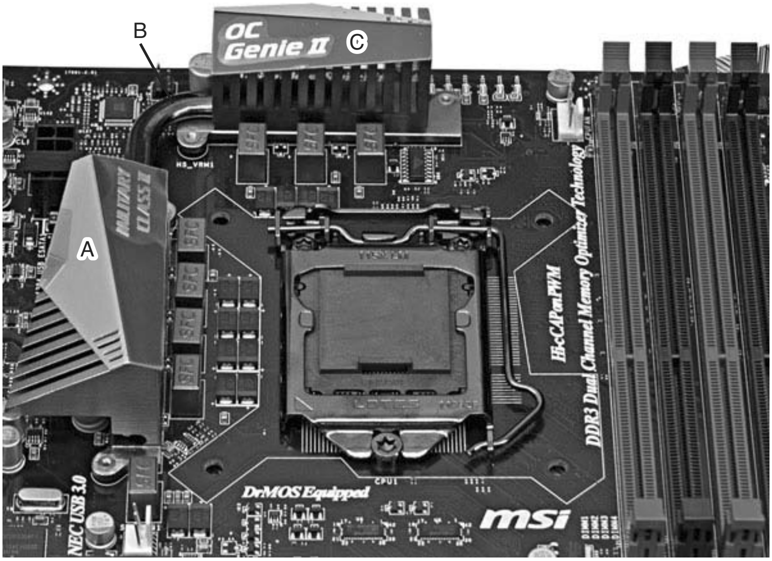


Figure 4-19 Motherboard with heat pipe cooling. Heat is transferred from components under heat sink (A) via heat pipe (B) to be dissipated by radiator at rear of motherboard (C).

Video Card Cooling

Another major heat source in modern systems is the video card's graphics processing unit (GPU) chip, which renders the desktop, graphics, and everything else you see on your computer screen. With the exception of a few low-end video cards, almost all video cards use active heat sinks to blow hot air away from the GPU.

However, the memory chips on a video card can also become very hot. To cool both the GPU and video memory, most recent midrange and high-end video card designs use a fan shroud to cool both components. Fan shrouds often require enough space to prevent the expansion slot next to the video card from being used.

Figure 4-20 illustrates a typical video card with a two-slot fan shroud.

Case Fans

Most ATX chassis have provisions for at least two case fans: one at the front of the system and one at the rear of the system. Case fans can be powered by the motherboard or by using a Y-splitter connected to a four-pin Molex power connector. Case fans at the front of the system should draw air into the system, while case fans at the rear of the system should draw air out of the system.

Figure 4-20 The EVGA GeForce GTX 580 is a high-performance PCI Express x16 video card that requires a two-slot fan shroud. Image courtesy of EVGA Corporation.

Figure 4-21 shows a typical rear case fan. You can plug fans like this into the three-prong chassis fan connection found on many recent motherboards or into the 4-pin Molex drive power connector used by hard drives. If the motherboard power connector is used, the PC Health or hardware monitor function found in many recent system BIOS setup programs can monitor fan speed (refer to Figure 4-10).

NOTE Some case fans that can be powered by a Molex power connector include a special power cable that permits the fan speed to be monitored by the motherboard, even though the motherboard is not used to power the fan.

Case fans are available in various sizes up to 200mm (80, 92, and 120mm are the most common sizes). Measure the opening at the rear of the case to determine which fan size to purchase. Some systems, such as the one shown earlier in Figure 4-11, might feature two rear fans or a rear fan and a top fan.

Thermal Compound

When passive or active heat sinks are installed on a processor, northbridge or south-bridge chip, GPU or other component, **thermal compound** (also known as thermal transfer material, thermal grease, or phase change material) must be used to provide the best possible thermal transfer between the component and the heat sink.

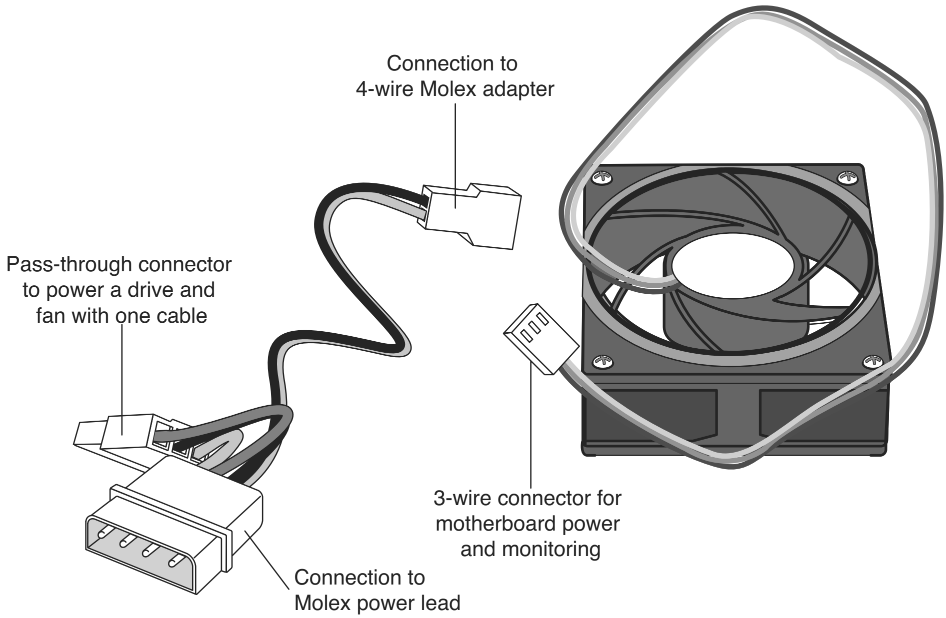


Figure 4-21 A case fan that can be plugged into the motherboard or into a Molex power connector.

Heat sinks supplied with boxed processors might use a preapplied phase-change material on the heat sink, whereas OEM processors with third-party heat sinks usually require the installer to use a paste or thick liquid thermal grease or silver-based compound. Coolers for northbridge or southbridge chips might use thermal grease or a phase-change pad.

If the thermal material is preapplied to the heat sink, make sure you remove the protective tape before you install the heat sink. If a third-party heat sink is used, or if the original heat sink is removed and reinstalled, carefully remove any existing thermal transfer material from the heat sink and processor die surface. Then, apply new thermal transfer material to the processor die before you reinstall the heat sink on the processor. Figure 4-22 illustrates the application of thermal compound to a northbridge chip before attaching a heat sink.

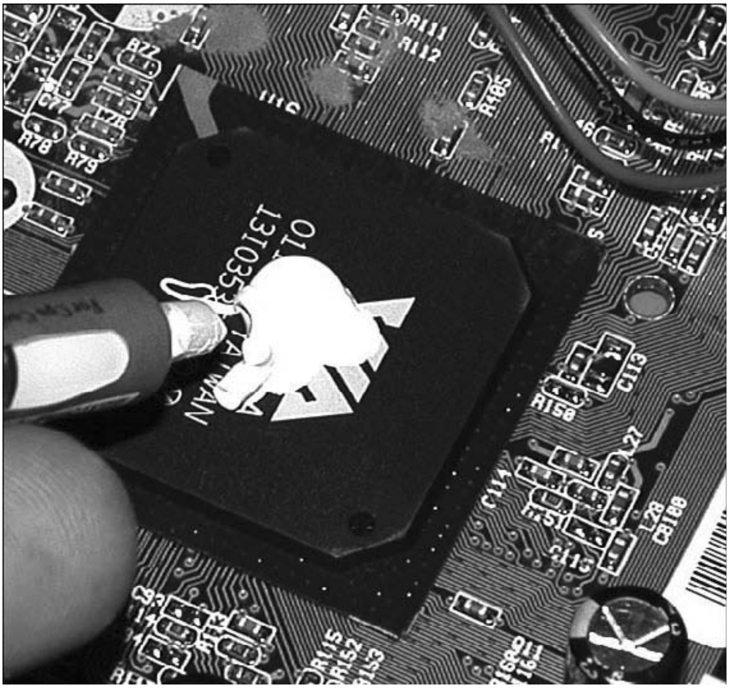


Figure 4-22 Applying thermal grease to the northbridge chip.

Exam Preparation Tasks

Review All the Key Topics

Review the most important topics in the chapter, noted with the key topics icon in the outer margin of the page. Table 4-4 lists a reference of these key topics and the page numbers on which each is found.

Key Topic

Table 4-4 Key Topics for Chapter 4

Key Topic Element	Description	Page Number
Text	Power supply converts AC to DC	130
Text	A typical ATX power supply	130
Figure 4-1	Power supply ratings	131
List	Determining the wattage rating needed for a replacement power supply	132
List	Voltage ranges supported by power supplies	133
Figure 4-4	20-pin, 24-pin, and ATX12V and AUX connectors	136
Figure 4-5	Power supply pinouts	136
Figure 4-6	Power supply connectors for peripheral and modern motherboards	137
List	Steps for removing the power supply	139
List	Symptoms of an overloaded power supply	141
Text	Fan failure indicators	142
List	Causes for a "dead" system	143
List	Diagnosing power supply problems	143
List	Causes of overheating	144
Text	Multimeter test procedures	150
Table 4-3	Acceptable voltage levels	153
List	Power supply hazards	154
Text	Surge suppressors	156
Text	Battery backup units	158
Text	Power conditioning units	161
Text	Cooling motherboard chipsets	162

Complete the Tables and Lists from Memory

Print a copy of Appendix A, "Memory Tables," (found on the CD), or at least the section for this chapter, and complete the tables and lists from memory. Appendix B, "Memory Tables Answer Key," also on the CD, includes completed tables and lists to check your work.

Define Key Terms

Define the following key terms from this chapter, and check your answers in the glossary.

power supply, AC, DC, multimeter, surge suppressor, battery backup, thermal compound

Complete Hands-On Lab

Complete the hands-on labs, and then see the answers and explanations at the end of the chapter.

Lab 4-1: Check Power Supply Voltages

Scenario: You are a technician working at a PC repair bench. You need to determine whether the power supply is supplying correct voltage to the motherboard without opening the system.

Procedure: Start the system, open the BIOS setup program, and open the dialog that displays power levels (System Health, PC Health, System Monitor are typical names). Check the voltage levels listed against those listed in Table 4-3.

> **NOTE** If the system does not display voltage levels in the system BIOS, use a multimeter and the information in Figure 4-5, Table 4-2, and Table 4-3 to check voltage levels.

Lab 4-2: Check for Airflow Problems Inside the System

Scenario: You are a technician working at a PC repair bench. You need to determine whether the cable layout inside the system may be causing overheating.

Procedure: Use the procedure for Lab 4-1 to check system temperature after running the system for about a half-hour. Record the current temperature. Shut down the system, unplug it from AC power, and open the system. Compare the interior of the system to Figures 4-11 and 4-12. If the system resembles Figure 4-11, the system needs better cable organization.

Answer Review Questions

Answer these review questions and then see the answers and explanations at the end of the chapter.

1. Which of the following would you use to keep the power supply working properly? (Choose two.)
   a. Surge protector
   b. Extra power supply
   c. UPS units
   d. Multimeter

2. Power supplies are rated using which of the following units?
   a. Amps
   b. Volts
   c. Watts
   d. Output

3. Newer tower-case computers' power supplies typically have which of the following power output ratings?
   a. 300 watts
   b. 400 watts
   c. 250 watts
   d. 500 watts or higher

4. Most power supplies in use today are designed to handle which two voltage ranges? (Choose two.)
   a. 115
   b. 300
   c. 230
   d. 450

5. Which of the following are causes of power supply overheating?
   a. Overloading the power supply.
   b. Fan failure.
   c. Dirt or dust.
   d. All of these options are correct.

6. How many pins are used for the main power connection by recent ATX/BTX motherboards with ATX12V 2.2 power supplies?
   a. 24
   b. 48
   c. 32
   d. 16

7. What is the four-pin square power connector on the motherboard used for?
   a. Extra power to PCIe slots
   b. 5-volt power for fans
   c. 12-volt power for processors
   d. 12-volt power for fans

8. What is the six-pin power lead on the power supply used for?
   a. Extra power to PCIe x16 cards
   b. Extra power for PCI cards
   c. Power for case fans
   d. Power supply diagnostics

9. Which of the following steps would you use to remove a power supply?
   a. Shut down the computer. If the power supply has an on/off switch, turn it off as well.
   b. Disconnect the AC power cord from the computer.
   c. Disconnect power connections from the motherboard, hard drives, and optical drives.
   d. All of these options are correct.

10. To avoid power supply hazards you must never do which of the following? (Choose two.)

- **a.** Disassemble the power supply.
- **b.** Put metal tools through the openings.
- **c.** Switch the voltage to 220.
- **d.** Put a smaller power supply in the computer.

11. Which device provides emergency power to a computer in case of a complete power failure?

- **a.** UTP
- **b.** UPS
- **c.** Power strip
- **d.** Surge protector

12. What is the minimum time recommendation for a UPS to supply power for an individual workstation?

- **a.** 30 minutes
- **b.** 45 minutes
- **c.** 1 hour
- **d.** 15 minutes

13. Which of the following correctly describe an SPS? (Choose all that apply.)

- **a.** The battery on an SPS is only used when the AC power fails.
- **b.** An SPS is on all the time.
- **c.** A momentary gap in power occurs between loss of AC power and when the SPS comes online.
- **d.** An SPS is far less expensive than a UPS.

14. When a system is dead and gives no signs of life when you turn on the computer, which of the following might be the cause? (Choose all that apply.)

- **a.** Defects in AC power to the system
- **b.** Power supply failure or misconfiguration
- **c.** Temporary short circuits in internal or external components
- **d.** Power button or other component failure

15. Processors and other components use a finned metal device to help with cooling. What is this device called? (Choose two.)

- **a.** Passive heat sink
- **b.** Thermal compound
- **c.** Active heat sink
- **d.** Chassis heat sink

16. What is the purpose of thermal compound?

- **a.** Provides the best possible thermal transfer between a component and its heat sink
- **b.** Provides the best possible thermal transfer between a component's heat sink and its fan
- **c.** To negate the effects of thermal contraction and expansion in adapter cards
- **d.** Provides the best possible thermal transfer between the northbridge and its fan

Answers to Hands-On Lab

Lab 4-1: Check Power Supply Voltages

Answer: If the voltage levels are within limits, the power supply is healthy. If any of the voltage levels are out of range, the power supply should be replaced with a power supply of the same or higher wattage rating.

Lab 4-2: Check for Airflow Problems Inside the System

Answer: Use cable ties and reroute long cables between the drive bays at the back wall of the system or along the edge of the motherboard to reduce snarls and improve airflow. After reassembling the system, reconnecting it to AC power, and booting the system to the BIOS setup program, recheck system temperature after running the system for a half-hour. If the temperature is lower, you have improved airflow inside the system. Even if the system temperature remains the same, you have made it easier to work inside the system in the future.

Answers and Explanations to Review Questions

1. **A, C.** To keep your power supply up and running and to help prevent damage from power surges, you should use a surge protector. The UPS will supply power for a short period of time to the computer system in case of total power outage.
2. **C.** Power supplies are rated in watts, and the more watts a power supply provides, the more devices it can safely power.
3. **D.** Most newer tower computers have 500 watt or larger power supplies in them because of the greater number of drives and expansion cards that are available now.
4. **A, C.** Standard North American power is 115 volts, and power in most parts of Europe and Asia is 230 volts. Some power supplies have a slider on the back to switch between the two voltages.
5. **D.** All of the listed reasons can cause damage to the power supply as well as overheating your computer.
6. **A.** Most of the newer power supplies in use today have 24 pins. Older motherboards have a 20-pin connection.
7. **C.** This connector is the ATX12V connector, which provides 12V power dedicated to the processor (a voltage regulator on the motherboard reduces 12V to the actual power required by the processor).
8. **A.** The six-pin (or 6+2 pin) power supply lead provides additional power needed by high-performance PCIe x16 cards, such as those used for SLI or for CrossFire X multi-GPU installations.
9. **D.** All of the listed answers are correct. You must disconnect from the wall first; then once inside the computer unhook the connection to the motherboard, drives, and other devices.
10. **A, B.** The capacitors inside the power supply retain potentially fatal voltage levels. To prevent shock you should not disassemble power supplies or stick in a metal object such as a screwdriver.
11. **B.** A UPS (uninterruptible power supply) will keep a standard desktop up and running in case of a complete power outage.
12. **D.** UPSs are designed to supply power to a computer long enough for you to complete a formal shutdown.
13. **A, C, D.** When an SPS is used there is a momentary gap, usually about 1ms or less, between when the power goes off and when the SPS starts supplying power. SPSs are also less expensive and are not used at all times.

14. **A, B, C, D.** When turning on a system that shows no signs of life you must consider all of these as potential problems.

15. **A, C.** All processors require a heat sink. A heat sink is a finned metal device that radiates heat away from the processor. An active heat sink (a heat sink with a fan) is required for adequate processor cooling on current systems. Some older systems used a specially designed duct to direct airflow over a processor with a passive heat sink (a heat sink without a fan). Most motherboards' northbridges use passive heat sinks or heat pipes.

16. **A.** Thermal compound (also known as thermal transfer material, thermal grease, or phase change material) provides for the best possible thermal transfer between a component (for example a CPU) and its heat sink. This prevents CPU damage. The fan and adapter cards should not have thermal compound applied to them.

This page intentionally left blank

Index

Symbols and Numerals

A

B

C

D

E

F

G

H

I

M

N

P

Q

R

S

T

U

V

W

X - Z