EXAM CRAM

CompTIA® A+

220-701
220-702

Fourth Edition

CD FEATURES 200 PRACTICE QUESTIONS

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DAVID L. PROWSE

CompTIA A+ Exam Cram, Fourth Edition

ISBN-13: 9-0-7897-4242-1

ISBN-10: 0-7897-4242-X

Library of Congress Cataloging-in-Publication Data

Prowse, David L.

CompTIA A+ exam cram / David L. Prowse. -- 4th ed.

p. cm.

ISBN 978-0-7897-4242-1 (pbk. w/cd)

1. Electronic data processing personnel--Certification. 2. Computer technicians--Certification--Study guides. 3. Microcomputers--Maintenance and repair--Examinations--Study guides. 4. Computing Technology Industry Association--Examinations--Study guides. I. Title.

QA76.3.P785 2010

004.165--dc22

2009034318

Printed in the United States of America

First Printing: October 2009

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Introduction

Welcome to the *CompTIA A+ Exam Cram*, Fourth Edition. This book prepares you for the CompTIA A+ Essentials Exam (number 220-701), and the CompTIA A+ Practical Application Exam (number 220-702) Imagine if you will, that you are at a testing center and have just been handed the passing scores for these exams. The goal of this book is to make that scenario a reality. I am very happy to have the opportunity to serve you in this endeavor. Together, we can accomplish your goal of attaining the CompTIA A+ certification.

Target Audience

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 for persons who have experience working with desktop PCs and laptops and want to cram for the A+ certification exam—*cram* being the key word. This book does not cover everything in the PC world; how could you in such a concise package? However, this guide is fairly thorough and should offer you a lot of insight…and a whole lot of test preparation.

If you do not feel that you have the required experience, have never attempted to troubleshoot a computer, or are new to the field, then I recommend the A+ Exam Certification Guide, which goes into much more depth than this text. On a side note, another great reference book that should be on every PC technician's shelf is the latest edition of *Upgrading and Repairing PCs* by Scott Mueller, published by Que.

There are essentially two types of people that will be reading this book: those who want a job in the IT field, and those who want to keep their job. For those of you in the first group, the new CompTIA A+ certification can have a powerful career impact, increasing the chances of securing a position in the IT world. For those in the second group, preparing for the exams serves to keep your skills sharp, and your knowledge up to date, making you a well-versed and well-sought after technician.

Of course I know that some of you are picking this book up solely for the practice exams, which are by the way located directly after Chapter 17, "Taking the Real Exams," and more are on the CD. But I recommend against solely studying the practice questions. This book was designed from the ground up to build your knowledge in such a way that when you get to the practice exams, they will act as the final key to passing the real exams. The knowledge in the chapters is the cornerstone, whereas the practice exam questions are the battlements. Complete the entire book and you will have built yourself an impenetrable castle of knowledge.

About the Latest CompTIA A+ Exams

The newest versions of the exams (released in 2009) are known as the CompTIA A+ Essentials Exam (number 220-701), and the CompTIA A+ Practical Application Exam (number 220-702). There are quite a few changes and additions to these latest versions of the A+ exams including

- Windows Vista has been incorporated into the new objectives.
- Older operating systems such as Windows 95, 98, Me, and NT have been removed.
- Newer multicore processor technologies such as Core 2 Duo have been added.
- Newer hard drive and memory technologies have been added.
- The A+ troubleshooting process has been updated.
- Increased amount of networking and security topics, with increased difficulty.

This book covers all these changes and more within its covers.

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

Note

Note: Those who have been certified in the most recent version of CompTIA A+ (2006 objectives) by taking 220-601 and one of the following: 220-602, 220-603 and 220-604 exams are eligible to update their currency through taking the CompTIA A+ bridge exam (one exam, BR0-003), which covers the new 2009 objectives.

About This Book

There is a lot of new information (and changing information) on the new A+ exams, so the people at Exam Cram and I decided to start this book from scratch. Every single bit of content is all new. The book is broken down into 17 chapters, each pertaining to particular objectives on the exam. Because the official CompTIA objectives can have very long names that sometimes deal with multiple subjects, I have divided the chapters into more manageable (and memorable) topics. All the questions in this book refer to these topics. Chapter topics and the corresponding CompTIA objectives are listed in the beginning of each chapter.

For the most part, I've structured the exam topics in this book to build on one another. Because of this I suggest that you read this entire book in order to best prepare for the CompTIA A+ exams. In the case that you want to review a particular topic, if your CD practice exam identifies a topic deficiency, for example, the topics are listed at the end of this introduction. In addition, you can use the index or the table of contents to quickly find the concept you are after.

Chapter Format and Conventions

Every Exam Cram chapter follows a standard structure and contains graphical clues about important information. The structure of each chapter includes the following:

- **Opening topics list:** This defines the topics to be covered in the chapter; it also lists the corresponding CompTIA A+ objective numbers.
- **Topical coverage:** The heart 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 between two and four topics each.
- **Cram Quiz questions:** At the end of each topic is a quiz. The quizzes, and ensuing explanations, are meant to gauge your knowledge of the subjects. If the answers to the questions don't come readily to you, consider reviewing individual topics or the entire chapter. In addition to being in the chapters, you can find a PDF of all the Cram Quiz questions compiled in one place on the CD.

- **Additional Reading and Resources:** At the end of each chapter, I list other sources of information, including books and websites, if you want to learn more about a particular topic.
- **Exam Alerts, Sidebars, and Notes:** These are interspersed throughout the book. Watch out for them!

> **ExamAlert**
>
> This is what an Exam Alert looks like. Normally, an alert stresses concepts, terms, hardware, software, or activities that are likely to relate to one or more certification test questions.

Additional Elements

Beyond the chapters, there are a few more elements that I've thrown in for you. They include:

- **Practice Exams:** There are four practice exams in total, consisting of 100 questions each. Two of them are directly after Chapter 17 within the book. There is one for each CompTIA A+ exam. The other two are located on the CD that accompanies this book, again, one for each exam.
- **Cram Sheet:** The tear-out Cram Sheet is located right in the beginning of the book. This is designed to jam some of the most important facts you need to know for the exam into one small sheet, allowing for easy memorization.

The Hands-On Approach

For this book, I built a new desktop computer using components that I believe are a good example of what you will see in the field today, and for a while to come; and are representative of the types of technologies that will be covered in the exams. I refer to the components in this system from Chapter 2, "Motherboards" onward. I like to put things into context whenever possible. By referencing the parts in the computer during each chapter, I hope to infuse some real-world knowledge and to solidify the concepts you need to learn for the exam. I believe that this more hands-on approach can help you to visualize concepts better and recommend that every PC technician build their own PC at some point (if you haven't already). This can really help to reinforce the ideas and concepts expressed in the book. I also recommend that you work with two computers while going through this book: one with Windows Vista, and one with Windows XP. Another option is to run one computer with one of the operating systems mentioned and a virtual machine running the other operating system.

Within these pages I refer to various ancillary websites, most notably;

- *Microsoft's TechNet*—http://technet.microsoft.com
- *Microsoft Help and Support*—http://support.microsoft.com (previously known as the Microsoft Knowledge Base or MSKB).

As an IT technician, you will be visiting these sites often; they serve to further illustrate and explain concepts covered in this text.

Goals for This Book

I have three main goals in mind while preparing you for the CompTIA A+ exams.

My first goal is to help you understand A+ topics and concepts quickly and efficiently. To do this, I try to get right to the facts that are necessary for the exam. To drive these facts home, the book incorporates figures, tables, real-world scenarios, and simple to-the-point explanations. Also, in Chapter 17, you can find test-taking tips and a preparation checklist that gives you an orderly step-by-step approach to taking the exam. Be sure to complete every item on the checklist! For students of mine that truly complete every item, there is an extremely high pass rate for the exams.

My second goal for this book is to provide you with more than 600 *unique* questions to prepare you for the exam. Between the Cram Quizzes and the practice exams, that goal has been met, and I think it will benefit you greatly. Because CompTIA reserves the right to change test questions at any time, it is difficult to foresee exactly what you will be asked on the exam; however I think you will find that a good amount of the questions in this book are similar to the real questions. Regardless, to become a good technician, it is important to know the *concept*, not just memorize questions. To this effect each question has an explanation and maps back to the topic (and chapter) that was covered in the text. I've been using this method for more than a decade with my students (over two thousand of them) with great results.

My final goal is to provide support for this and all my titles, completing the life cycle of learning. I do this through my personal website: www.DavidLProwse.com. It has additional resources for you and is set up to take questions from you about my titles. The site requires free registration to gain access to the additional A+ resources or to post questions; however, all you need is a valid email address, so join my little community! I'll try my best to get to your questions ASAP. All personal information is kept strictly confidential.

Good luck to you in your certification endeavors. I hope you benefit from this book. Enjoy!

Sincerely,

David L. Prowse

Exam Topics

Table I.1 lists the exam topics covered in each chapter of the book.

TABLE I.1 **Exam Cram CompTIA A+ Exam Topics**

Exam Topic	Chapter
Troubleshooting Theory Troubleshooting Examples and Concepts	1
Motherboard Components and Form Factors The BIOS Installing and Troubleshooting Motherboards	2
CPU 101 Installing and Troubleshooting CPUs	3
RAM Basics and Types of RAM Installing and Troubleshooting DRAM	4
Understanding and Testing Power Power Devices Power Supplies	5
Magnetic Storage Media Optical Storage Media Solid State Storage Media	6
Installing and Upgrading to Windows Vista Installing and Upgrading to Windows XP	7
Windows User Interfaces System Tools and Utilities Files, File Systems, and Disks	8
Updating Windows Maintaining Hard Disks	9
Repair Environments and Boot Errors Windows Tools and Errors Command-Line Tools	10

TABLE I.1 **Continued**

Exam Topic	Chapter
Installing, Configuring, and Troubleshooting Visible Laptop Components Installing, Configuring, and Troubleshooting Internal Laptop Components	11
The Video Subsystem The Audio Subsystem Input/Output, Input Devices, and Peripherals	12
Printer Types and Technologies Installing, Configuring, and Troubleshooting Printers	13
Networking Fundamentals Network Cabling and Connectors Troubleshooting Network Connectivity Installing and Configuring a SOHO Network	14
Basics of Data Security Authentication Malicious Software File Security	15
Safety and Environmental Procedures Professionalism and Communication Skills	16
Getting Ready and the Exam Preparation Checklist Tips for Taking the Real Exam Beyond the CompTIA A+ Certification	17

CHAPTER 5

Power

This chapter covers the following A+ exam topics:

- Understanding and Testing Power
- Power Devices
- Power Supplies

You can find a master list of A+ exam topics in the "Introduction."

This chapter covers CompTIA A+ 220-701 objectives 1.3 and 2.5 and CompTIA A+ 220-702 objectives 1.1, 1.2, and 1.4.

Everything relies on power. Clean, well-planned power is imperative in a computer system. It's so important, that I almost made this the first chapter of the book. I can't tell you how many power-related issues I have troubleshot in the past. Many of the issues that you see concerning power are due to lack of protection and improper planning, and as such you will see several questions (if not more) on the A+ exams regarding this subject.

Imagine a scenario in which you work for a technical services division of a company. You are required to install a new, more powerful power supply in a computer that contains many devices and requires a lot of electricity. You need to install the computer in a new area of the company's building. This requires you to plug the computer into an AC receptacle that has never been used or tested.

What kind of power supply should you select? How can you verify that the AC outlet is properly wired? And how can you protect the computer? This chapter answers all those questions and furnishes you with the knowledge you need to install, test, and troubleshoot power supplies and test power that comes from the wall outlet.

Understanding and Testing Power

The power for your computer is derived from electricity, which is basically the flow of electric charge. Electricity is defined and measured in several ways, most commonly

- *Voltage*, a representation of potential energy; sometimes it's more simply referred to as pressure; its unit of measurement is volts (V).
- *Wattage* or electric power, the rate of electric energy in a circuit, measured in watts (W).
- *Amperage* or electric current, the movement of electric charge, measured in amperes or amps (A).
- *Impedance*, the amount of resistance to electricity, measured in ohms (Ω).

Each of these is covered in this chapter, but by far the most common of these that you will be testing is voltage. Here are two examples of voltages you are probably familiar with:

- 120 Volts AC (the voltage associated with many U.S. homes)
- 5 Volts DC (the voltage associated with some of the internal power connections in your PC)

The difference in these two examples (aside from the amount of volts) is that a house's outlets use alternating current (AC), in which the flow of electrons alternate, and your computer, again internally, uses direct current (DC), in which the flow of electrons is one way.

ExamAlert

In AC, electron flow alternates.

In DC, electrons flow one way.

Back to our scenario; because you can't control who wired the AC outlet that you will be connecting the computer to, or how clean the power is that comes from your municipality, you should test the outlet prior to plugging the computer in. Two good tools to use when testing are a receptacle tester and a multimeter.

ExamAlert

Warning: Read through these sections carefully before attempting to test a live AC outlet. If you still feel unsure, contact a qualified electrician to test and make repairs to an AC outlet.

Testing an AC Outlet with a Receptacle Tester

Type B AC outlets are the most common, and might also be referred to as wall sockets, electric receptacles, or power points. It is type B that you need to be concerned with for the A+ exam. If any of the hot, neutral, or ground wires are connected improperly, the computer connected to the outlet is a sitting duck, just waiting for irreparable damage. To ensure that the AC outlet is wired properly, you can use a receptacle tester, like the one shown in Figure 5.1. These are inexpensive and are available at most home improvement stores and electrical supply shops. When you plug in the receptacle tester, it tells you if the receptacle is wired properly or indicates which wires are incorrect.

FIGURE 5.1 **A common receptacle tester and labeled receptacle**

In Figure 5.1 the test has passed. With this particular tester, two yellow lights tell you that the outlet is wired correctly. Any other combination of lights tells you that there is a wiring error. The different combinations are usually labeled on the tester itself; for example, an open ground error is displayed by one single, yellow light on this tester. Important: If you receive any erroneous readings or if there are no lights at all, *do not use the outlet* and contact your supervisor and/or building management so that they can bring in a licensed electrician to fix the problem.

ExamAlert

If you find an AC outlet is improperly wired, contact your supervisor and/or building management to resolve the problem.

Testing an AC Outlet with a Multimeter

Every PC technician should own a multimeter, and we use one throughout this chapter. A multimeter is a hand-held device that, among other things, can be used to measure amps and impedance, and to test voltage inside a computer and from AC outlets. It has two leads, a black and a red. Whenever using the multimeter, try to hold both of the multimeter leads with one hand, and hold them by the plastic handles; don't touch the metal ends. It will be like holding chopsticks but is a safer method, reducing the severity of electric shock in the uncommon chance that one occurs. To test an AC outlet with a multimeter, run through the following steps:

1. Place the multimeter's black lead in the outlet's ground. (The parts of the outlet are labeled in Figure 5.1.)
2. Place the red lead in the hot opening
3. Turn on the multimeter to test for volts AC (sometimes labeled as VAC). Hold the leads steady and check for readings. Optimally, the reading will hover around 115 volts or 120 volts depending on where you are in the United States. Watch the readings for a minute or so. Remember the reading or range of readings that display. A common reading is shown in Figure 5.2.
4. Turn off the multimeter.
5. Remove the red lead.
6. Remove the black lead.

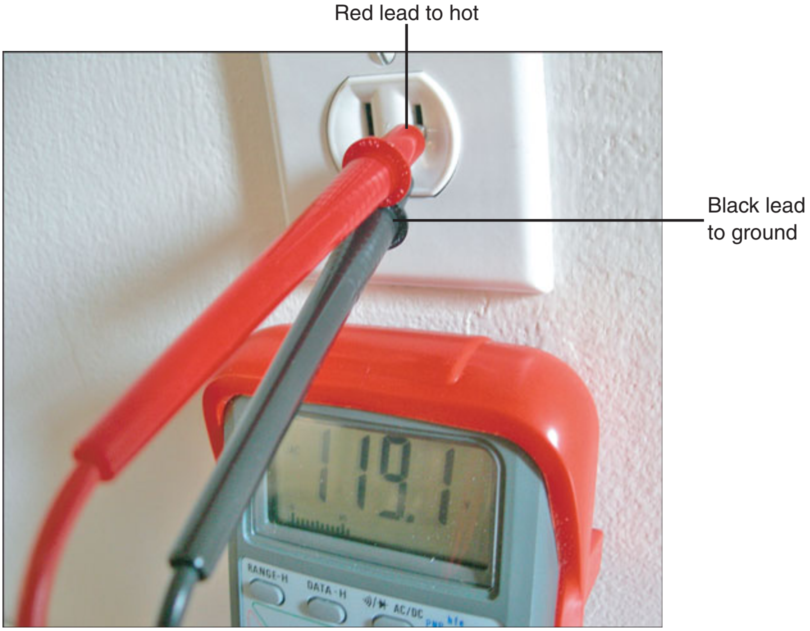

FIGURE 5.2 **A receptacle tested with a multimeter**

What was your reading? A steady reading closest to 120 volts is desirable. It might be less in some areas, but the key is that it's steady at one voltage; this is also known as *clean power*. If the reading fluctuates a lot, say between 113 volts and 121 volts, for example, you have one of the varieties of *dirty power*. This could be because too many devices use the same circuit or because power coming from electrical panel or from the municipal grid fluctuates, maybe because the panel or the entire grid is under/overloaded. A quick call to your company's electrician can result in an answer and possibly a long-term fix. However, we are concerned with an immediate solution, which in this case will be to install an uninterruptible power supply (UPS) or other line-conditioning device between the computer and the AC outlet. This can regulate the output of AC to the computer.

ExamAlert

To keep an AC outlet's voltage steady, use a UPS or line conditioner.

You can also test the neutral and ground wires in this manner. You should be especially concerned with whether the ground wire is connected properly.

Previously we showed how to test this with the receptacle tester, but to test this with the multimeter, connect the black lead to ground and the red lead to neutral. This should result in a reading of 0 volts. Any other reading means that the outlet is not grounded properly, which can result in damage to a computer that connects to it. You can also use a voltage detector, which is a pen-shaped device that beeps when it comes into contact with voltage. On a properly grounded outlet, the only part that should give audible beeps is the hot. Everything else including the screw and outlet plate should not register any sounds. If sounds do register by simply touching the outlet plate with the voltage detector, the outlet is not grounded properly. If this is the case, or if you got any other reading besides 0 volts on the multimeter, contact an electrician right away.

Cram Quiz

Cram QuizAnswer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

1. What tool would you use to test the amount of voltage that is coming from an AC outlet?

❍ **A.** Multimeter

❍ **B.** Voltage detector

❍ **C.** Receptacle tester

❍ **D.** Impedance tester

2. Which of the following is a representation of potential energy?

❍ **A.** Wattage

❍ **B.** Voltage

❍ **C.** Impedance

❍ **D.** Amperage

3. Which wire when tested should display zero volts on a multimeter?

❍ **A.** Neutral

❍ **B.** Hot

❍ **C.** Ground

❍ **D.** Red

Cram Quiz Answers

1. **A.** The multimeter is the only testing tool that can display voltage numerically.
2. **B.** Voltage is a representation of potential energy; an analogy for voltage would be water pressure in a pipe.
3. **C**. When testing the ground wire with a multimeter, it should display a reading of zero volts.

Power Devices

Utilizing proper power devices is part of a good preventative maintenance plan and helps to protect a computer. You need to protect against several things:

- Surges
- Spikes
- Sags
- Brownouts
- Blackouts

A *surge* in electrical power means that there is an unexpected increase in the amount of voltage provided. This can be a small increase or a larger increase known as a spike. A *spike* is a short transient in voltage that can be due to a short circuit, tripped circuit breaker, power outage, or lightning strike.

A *sag* is an unexpected decrease in the amount of voltage provided. Typically, sags are limited in time and in the decrease in voltage. However, when voltage reduces further, a brownout could ensue. During a *brownout* the voltage drops to such an extent that it typically causes the lights to dim and causes computers to shut off.

A *blackout* is when a total loss of power for a prolonged period occurs. Another problem associated with blackouts is the spike that can occur when power is restored. In the New York area, it is common to have an increased amount of tech support calls during July; this is attributed to lightning storms! Quite often this is due to improper protection.

Some devices have specific purposes, and others can protect against more than one of these electrical issues. Let's describe a few of these devices.

Power Strips

A *power strip* is a group of sockets, usually in-line, with a flexible cable that plugs into an AC outlet. It enables for multiple devices to share a single receptacle in that outlet. Due to this, a maximum wattage rating can be applied to the device, for example, 3,000 watts is a decent amount. Interesting, a computer might have a 300-watt power supply, but on the average, it might use only 100 watts of that power while running. A monitor might use between 35 watts and 100 watts depending on the type of monitor. You can check the wattage rating on the back or side of most devices. Add the total for all devices connected to the power strip, and remember not to exceed the maximum rating. This concept applies to other devices in this section including surge protectors and UPSs.

Power strips might not have surge protection functionality. If they don't have surge protection capabilities, they cannot protect from any of the electrical issues (surges and spikes) listed in the previous section.

A power strip has a master on/off switch and usually has a 15-amp circuit breaker to prevent overloading. If an overload occurs, the circuit breaker trips, cutting power, and the device can usually be reset by pressing a black button normally located somewhere near the power button. Overloads occur because the power strip tries to pull too much current (amps) from the wall outlet, or when too much current is supplied *to* the power strip. As a rule of thumb, no more than four or five computers (and monitors) should use the same power strip and, therefore, the same circuit. This calls into question whether any other AC outlets connect to the same circuit. To find this out, a qualified electrician can use a circuit testing tool and locate all the outlets on the circuit in question, or this information might be included in your building's electrical diagram. By the way, you can also calculate the amount of computers and monitors that can connect to a circuit by their amperage rating. For example, at AC (wall-outlet level) a typical computer would draw 2 to 3 amps and perhaps another 2 amps for the monitor maximum. (Keep in mind that these are estimates.) So on a standard 15-amp circuit, it would be wise to have no more than three computers and three monitors running simultaneously.

Surge Protectors

A *surge protector* or surge suppressor is a power strip that also incorporates a metal-oxide varsistor (MOV) to protect against surges and spikes. Most power strips that you find in an office supply store or home improvement store have surge protection capability. The word *varsistor* is a blend of the two terms *variable resistor*.

ExamAlert

To protect against surges and spikes, use a surge protector!

Surge protectors are usually rated in joules, which are a way to measure energy, and in essence, the more joules the better. For computer systems, 1,000 joules or more is recommended. This joule rating gives you a sense of how long the device can protect against surges and spikes. Surges happen more often than you might think, and every time a surge happens, part of the varsistor is burned out. The higher the joule rating, the longer the varsistor (and therefore the device) should last. Most of today's surge protectors have an indicator light that informs you if the varsistor has failed.

Because surges can occur over telephone lines, RG-6 cable lines, and network lines, it is common to see input and output ports for any or all these on a decent surge protector. Higher-quality surge protectors have multiple MOVs not only for the different connections such as AC and phone, but also have multiple MOVs for the individual wires in an AC connection.

Uninterruptible Power Supplies

An *uninterruptible power supply (UPS)* takes the functionality of a surge suppressor and combines that with a battery backup. So now, our computer is protected not only from surges and spikes, but also from sags, brownouts, and blackouts.

> Exam**Alert**
>
> Use a UPS to protect your computer from power outages!

But the battery backup can't last indefinitely! It is considered emergency power and typically keeps your computer system running for 5 to 30 minutes depending on the model you purchase. Figure 5.3 shows an example of a typical inexpensive UPS. Notice that some of the outlets on the device are marked for battery backup *and* surge protection, whereas others are for surge protection only.

Most UPS devices also act as line conditioners, protecting from over and under-voltage; they condition (or regulate) the voltage sent to the computer. The device shown, and most UPS devices today, has a USB connection so that your computer can communicate with the UPS. When there is a power outage, the UPS sends a signal to the computer telling it to shut down, suspend, or stand-by before the battery discharges completely. Most UPSs come with software that you can install that enables you to configure the computer with these options.

FIGURE 5.3 **A common UPS**

UPS devices' output power capacity is rated in volt-amps (VA) and watts. Although you might have heard that volt-amps and watts are essentially the same, this is one of those times that they are somewhat different. The volt-amp rating is slightly higher due the difference between apparent power (when in battery backup mode) and real power (when pulling regular power from the AC outlet). For example, the device in Figure 5.3 has a volt-amp rating of 350 VA but a wattage rating of 200 watts. Generally, this is enough for a computer, monitor, and a few other devices, but a second computer might be pushing it given the wattage rating. The more devices that connect to the UPS, the less time the battery can last if a power outage occurs; if too many devices are connected, there may be inconsistencies when the battery needs to take over. Thus many UPS manufacturers limit the amount of battery backup-protected receptacles. Connecting a laser printer to the UPS is *not* recommended due to the high current draw of the laser printer; and *never* connect a surge protector or power strip to one of the receptacles in the UPS, to protect the UPS from being overloaded.

ExamAlert

Do *not* connect laser printers to UPS devices.

The UPS normally has a lead-acid battery that, once discharged, requires 10 hours to 20 hours to recharge. This battery is usually shipped in a disconnected state. Before charging the device for use, you must first make sure that the battery leads connect to the UPS. If the battery ever needs to be replaced, a red light will usually appear accompanied by a beeping sound. Beeping can also occur if power is no longer supplied to the UPS by the AC outlet.

There are varying levels of UPS devices, which incorporate different technologies. For example, the cheaper standby UPS (known as an SPS) might have a slight delay when switching from AC to battery power, possibly causing errors in the computer operating system. Although it isn't important to know these different technologies for the exam, you should realize that some care should be taken when planning the type of UPS to be used. When data is crucial, you had better plan for a quality UPS!

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

1. Which device should you use to protect against power outages?

- ❍ **A.** Multimeter
- ❍ **B.** UPS
- ❍ **C.** Fedex
- ❍ **D.** Surge protector

2. You want a *cost-effective* solution to the common surges that can affect your computer. Which device would be the best solution?

- ❍ **A.** UPS
- ❍ **B.** Surge protector
- ❍ **C.** Power strip
- ❍ **D.** Line conditioner

3. Which of these is an unexpected increase in voltage?

- ❍ **A.** Sag
- ❍ **B.** Blackout
- ❍ **C.** Spike
- ❍ **D.** Whiteout

Cram Quiz Answers

1. **B**. The UPS is the only item listed that protects the computer from power outages like blackouts and brownouts.
2. **B**. A surge protector is the right solution at the right price. A UPS is a possible solution but costs more than a surge protector. A line conditioner also would be a viable solution but, again, is overkill. And a power strip doesn't necessarily have surge protection functionality.
3. **C**. A spike (or a surge) is an unexpected increase in voltage. A sag is a decrease in voltage, a blackout is a power outage, and a whiteout is a blizzard, which could result in a blackout!

Power Supplies

Okay, now that we've tested our AC outlet and put some protective power devices into play, let's go ahead and talk power supplies. The power supply is in charge of converting the alternating current (AC) drawn from the wall outlet into direct current (DC) to be used internally by the computer. It feeds the motherboard, hard drives, optical drives, and any other devices inside of the computer. Talk about a single point of failure! That is why many higher-end workstations and servers have redundant power supplies.

Planning Which Power Supply to Use

It is important to use a reliable brand of power supply that is UL listed (certified). There are a few other things to take into account when planning which power supply to use in your computer:

- Type of power supply and compatibility
- Wattage and capacity requirements
- Amount and type of connectors

Now, in our scenario we said that we need a power supply that can support many devices in our workstation; one that will output a lot of power. In this scenario the computer has two IDE hard drives, a CD-Burner, a DVD-ROM, one SATA drive, and a PCIe video card. And let's just say that we use an ATX 12V 2.0 motherboard. So we need to look for a high–capacity, compatible ATX power supply with a decent amount of connectors for our devices. Let's discuss planning now.

Types of Power Supplies and Compatibility

The most common form factor today is Advanced Technology Extended (ATX). Depending on the type of ATX, the main power connector to the motherboard will have 20 pins or 24 pins. Table 5.1 shows a few different form factors and their characteristics. The key is compatibility. In our scenario we have a previously built computer, which means that the case and motherboard are already compatible. If this computer was *proprietary*, we could go to the computer manufacturer's website to find out the exact form factor, and possibly a replacement power supply for that model computer. Some third-party power supply manufacturers also offer replacement power supplies for proprietary systems. However, if this computer was custom built, we would need to find out the form factor used by the motherboard and/or case, and should open the computer and take a look at all the necessary power connections. Then we need to find a compatible power supply according to those specifications from a third-party power supply manufacturer. Table 5.1 displays the form factors you need to know for the exam.

TABLE 5.1 **Common Power Supply Form Factors**

Form Factor	Main Power Connector	Other Characteristic
ATX	P1 20-pin connector	An older standard but you will still support it!
ATX 12V 1.0 - 1.3	P1 20-pin connector & P4 4 pin 12V connector	Supplemental 6-pin AUX connector provides additional 3.3V and 5V supplies to the motherboard.
ATX 12V 2.0	P1 24-pin connector (backward compatible)	▶ 6-pin AUX was removed. ▶ SATA power cable is required.

Figure 5.4 gives examples of a P1 20-pin (the white connector) and P1 24-pin connector (the black connector). Toward the left of the black connector you notice it has an additional four pins that can be separated from the main group of 20 pins. Both have locking tabs to keep the P1 connector fastened to the motherboard. (In the figure this is shown only on the 20-pin connector.)

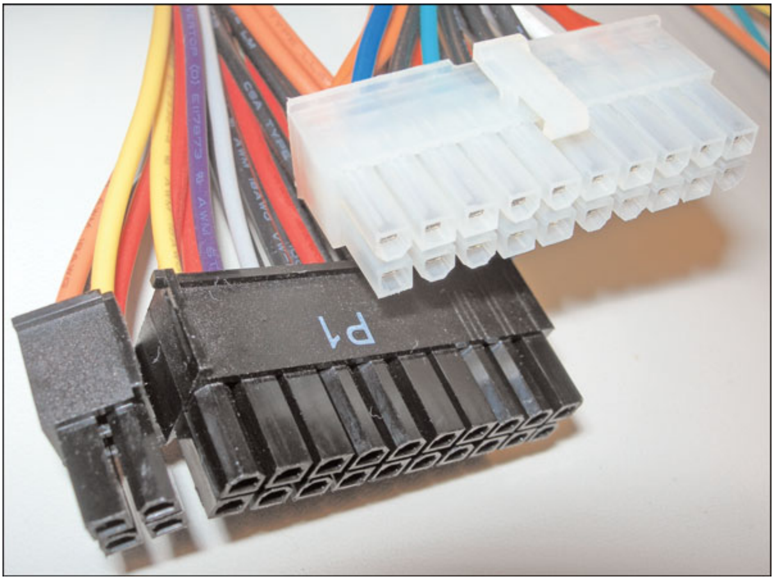

FIGURE 5.4 **24-pin and 20-pin power connectors**

ExamAlert

Original ATX power supplies connect to the motherboard with a 20-pin connector. Newer ATX 12V 2.0 power supplies connect with a 24-pin connector.

There are many other types of form factors such as microATX, BTX, and NLX (covered in Chapter 2, "Motherboards") and older form factors such as AT; however, the form factors listed in Table 5.1 are the important ones to know regarding power supplies for the A+ exam. For any other form factors, just remember that the power supply, case, and motherboard all need to be compatible.

Another important piece to consider is the type of case that is used. Larger cases require longer power cables to reach the devices. You can find the measurements for the cables on the power supply manufacturer's website. There are several different types of cases that you need to be familiar with:

- **Desktop:** Lies horizontally, usually has one 5¼-inch drive bay.
- **Mini-tower**: Stands vertically, usually has two or three drive bays.
- **Mid-tower**: Usually has three or four bays.
- **Full tower**: Usually has six bays.
- **Slim line**: Compaq and the Playstation III and other third-party case manufacturers use this case design.

Many power supply manufacturers also make computer cases and often sell them as a package or to be purchased separately.

Wattage and Capacity Requirements

Power supplies are usually rated in watts. They are rated at a maximum amount that they can draw from the wall outlet and pass on to the computer's devices. Remember that the computer will not always use all that power the way in which a light bulb does. And the amount depends on how many devices work and how much number crunching your processor does! In addition, when computers sleep or suspend, they use less electricity. What you need to be concerned with is the maximum amount of power all the devices need collectively. Most power-supply manufacturers today offer models that range from 300 watts all the way up to 1,000 watts. Although 300 watts is a decent amount of power for many computers, it might not suffice in our scenario. Devices use a certain amount of power defined in amps and/or watts. By adding all of the devices power consumption together, we can get a clearer picture of how powerful a power supply we need. Consult the manufacturer's web page of the device for exact requirements. We said that in our scenario the computer has two IDE hard drives, a CD-Burner, a DVD-ROM, a floppy drive, and one SATA drive and a PCIe video card. It also has a quad core processor and 2GB of RAM (in two sticks).

After doing the math, it appears that the computer in our scenario needs about 400 watts or so to run smoothly. The power supply we purchase should be rated slightly higher just in case, so in this scenario we would obtain a 450-watt or 500-watt power supply. Most power supplies are rated for 15 amps, so it is important to connect the computer to a 15-amp circuit or higher.

Amount and Type of Power Connectors

It is important to know how many of each type of power connector you need when planning which power supply to use. In our scenario we need four IDE power connectors (for the two hard drives, CD-Burner, and DVD-ROM), one floppy power connector, and one SATA power connector. You need to be familiar with each of these types of power connectors for the A+ exams. Be prepared to identify them by name and by sight. Table 5.2 defines the usage and voltages for the most common power connectors: Molex, mini, SATA, and PCIe, which are displayed in Figures 5.5 through 5.8.

TABLE 5.2 **Power Connectors**

Power Connector	Usage	Pins and Voltages
Molex	IDE hard drives, optical drives, and other devices	Red (5V), black (G), black (G), yellow (12V)
Mini	Floppy drives	Red (5V), black (G), black (G), yellow (12V)
SATA	Serial ATA hard drives	15-pin, 3.3V, 5V, and 12V
PCIe	PCI Express cards	6-pin

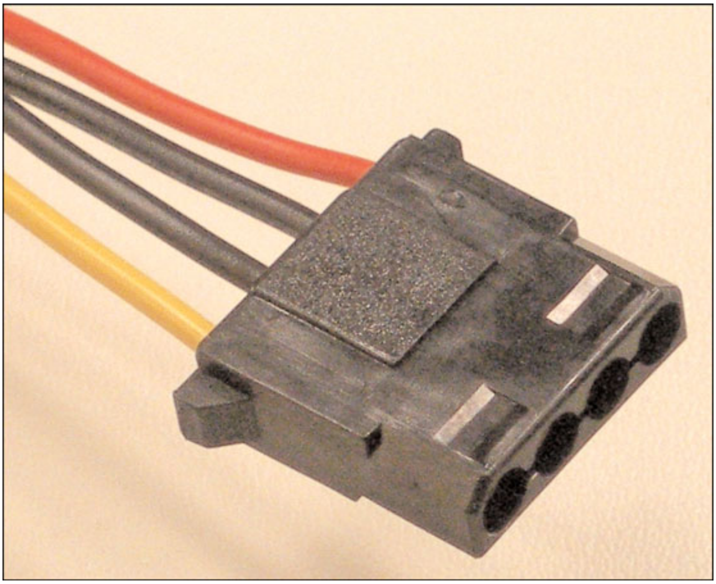

FIGURE 5.5 **Molex power connector**

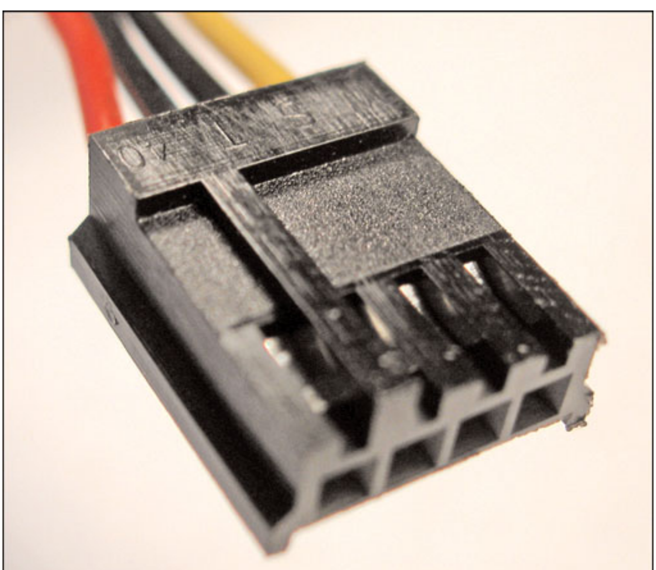

FIGURE 5.6 **Mini power connector**

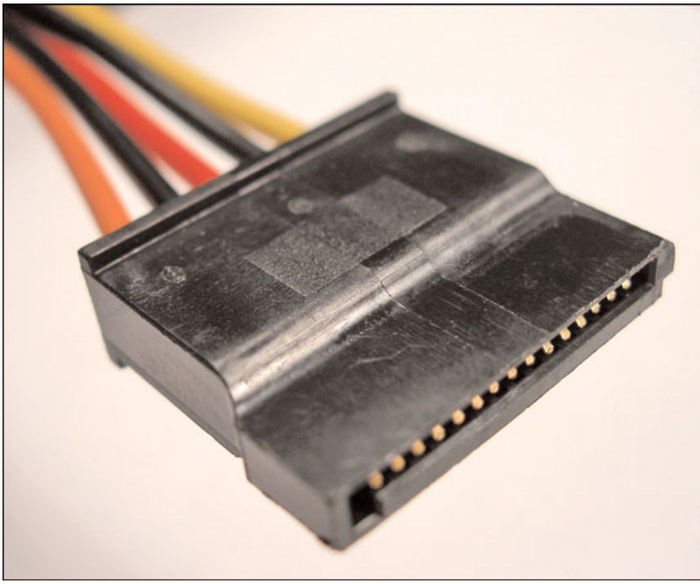

FIGURE 5.7 **SATA 15-pin power connector**

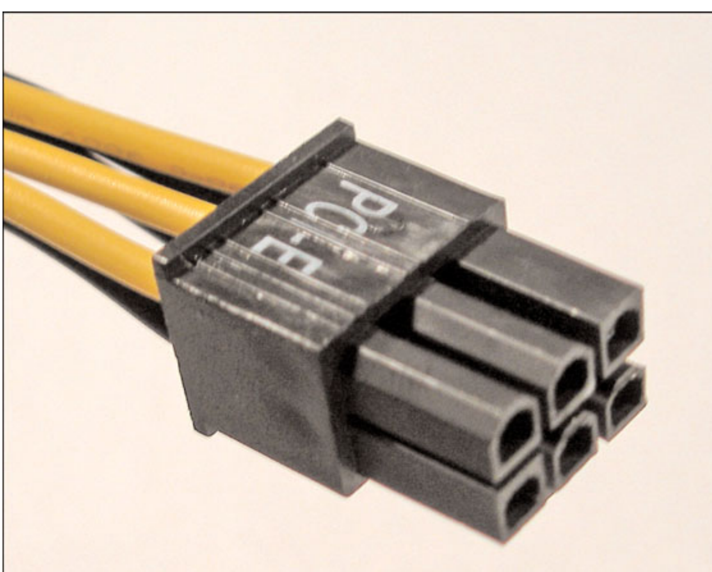

FIGURE 5.8 **PCIe 6-pin power connector**

Installing the Power Supply

When the power supply arrives, we can install it. But first, let's take a look at the back of the power supply to identify the components we see, as shown in Figure 5.9.

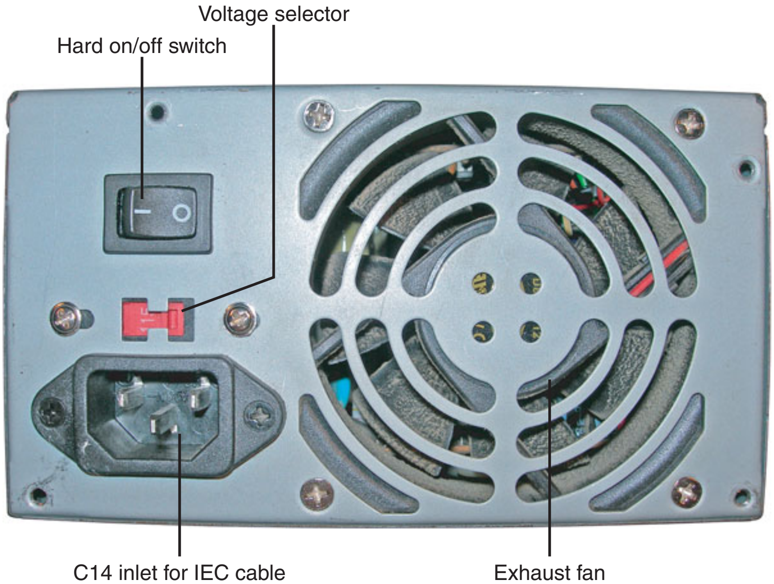

FIGURE 5.9 **Rear view of power supply**

On the top-left portion of Figure 5.9, we see a hard on/off switch sometimes referred to as a kill switch. This is a nice feature when troubleshooting PCs. Instead of disconnecting the power cable, we can shut off this switch. It works nicely in emergencies as well. Below that we see a red voltage selector switch. This should be set to 115V in the United States. It also has a 230V option to be used in other countries. (An additional adapter might be necessary for the different wall outlets you might encounter.) Never change the voltage selector switch while the computer is running. Be sure to check this setting before using the power supply. Some newer power supplies are now equipped with a universal input enabling you to connect the power supply to any AC outlet between 100V to 240V, without having to set a voltage switch. Below that we see the power cable inlet; this is known as a C14 inlet and is where we attach our power cord to the power supply. These inlets and cables that connect to them are defined by the IEC 60320 specification (previously the IEC 320 spec), and because of this many techs refer to the power cord as an IEC cable (which by the way stands for International Electrotechnical Commission).

This cord actually has a standard three-prong connector suitable for an AC outlet on one end and a C13 line socket on the other to connect to the power supply. To the right we see the power supply fan that is of great importance when troubleshooting power supplies.

If there is a power supply connected to the computer, turn off the computer and unplug the power supply. ATX motherboards are always receiving 5 volts even, when they are off, if the computer is plugged in. Be sure that you are employing antistatic methods. Remove the old power supply and prepare to install the new one.

You might want to test the power supply before installing it. This can be done by connecting a power supply tester (described in the next section), plugging in the power supply to the AC outlet, and turning on the hard on/off switch. Or you can test the power supply after it is installed by simply turning the computer on.

The power supply is placed inside the case and mounted with four standard screws that are screwed in from the back of the case. In some instances, a plastic housing inside the case might need to be removed. In addition, the power supply might not fit without the removal of other devices, such as the processor, and such, but in most cases (pun intended) you should install the power supply without too much trouble. Next, connect the P1 connector to the motherboard and attach the Molex, mini, SATA, and PCIe as necessary to their corresponding devices. Note that the P1 connector (20-pin or 24-pin main connector) can be plugged in only in one way and that there is a locking tab. Also, most other connectors are molded in such a way as to make it difficult to connect them backward. If you need a lot of strength to plug in the connector, check and make sure that it is oriented correctly. Don't force the connection. Afterward, remove any antistatic protection, and finally, plug the power supply into the AC outlet, turn on the hard on/off switch (if the power supply has one), and turn on the computer. Check to see if the fan in the power supply is working and if the computer boots correctly.

Troubleshooting Power Supply Issues

Installation of the power supply was easy, and there aren't usually many issues when doing so, but power supplies don't last forever. Moreover, many issues that occur with power supplies are intermittent making the troubleshooting process a little tougher. Your best friends when troubleshooting power supplies are going to be a multimeter, power supply tester, and your eyes and ears. Of course, always make sure that the power supply connects to the AC outlet properly before troubleshooting further. Here are a couple of the issues you may encounter with power supplies:

- Fan failure
- Fuse failure
- Quick death
- Slow death

Fan failure can be due to the fact that the power supply is old, extremely clogged with dirt, or that the fan was of cheaper design (without ball bearings). However, for the A+ exam it doesn't make a difference. As far as A+ is concerned, if the fan fails, the power supply needs to be replaced, and it makes sense. Chances are, if the fan has failed, other components of the power supply are on their way out also. It is more cost-effective to a company to simply replace the power supply than to have a technician spend the time opening it and trying to repair it. More important, although it is possible to remove and replace the fan by opening the power supply, this can be a dangerous venture because the power supply holds an electric charge, so the A+ rule is to never open the power supply.

ExamAlert

Do not open a power supply! If it has failed, replace it with a working unit.

Fuse failure can occur due to an overload or due to the power supply malfunctioning. Either way, the proper course of action is to replace the power supply. Do not attempt to replace the fuse. Chances are that the power supply is faulty if the fuse is blown. If it so happens that you need to test an individual fuse that was lying around, then use your multimeter. Make sure that your red lead is connected to the ohms (Ω) input and set the meter to Ohm (Ω). Touch the probes to both ends of the fuse. A good fuse should show zero ohm or display continuity. A bad or "blown" fuse will not show any reading. This is an example of testing impedance.

If the power supply dies a quick death, it might be because of several reasons from an electrical spike to hardware malfunction. First make sure that the IEC cable is connected properly to the power supply and to the AC outlet. Sometimes, it can be difficult to tell whether the power supply has failed or if it's something else inside or outside the computer system. You should check the AC outlet with your trusty receptacle tester and make sure that a circuit hasn't tripped, and verify that any surge protectors and/or UPS devices work properly. Depending on what you sense about the problem, you might decide to just swap out the power supply with a known good one. Otherwise, move on to the following numbered steps.

If the power supply is dying a slow death and is causing intermittent errors, it could be tough to troubleshoot. If you suspect intermittent issues, first make sure that the power cord is connected securely and then try swapping out the power supply with a known good one. Boot the computer and watch it for awhile to see if the same errors occur.

Whether the power supply has apparently failed completely or is possibly causing intermittent errors, and you can't figure out the cause to this point, continue through the following steps:

1. Remove the computer case.
2. Connect a power supply tester, as shown in Figure 5.10, to the P1 connector and look at the results. (Make sure you have the correct power supply tester; this depends on whether you have a 20-pin or 24-pin power connector.) These power supply testers normally test for +12V, –12V, +5V, –5V, and 3.3V, but they might not test every individual pin. If there are error lights, no lights, or missing lights for specific voltages on the tester, replace the power supply. If all the lights are green, move on to the next step.

FIGURE 5.10 **Testing a 24-pin P1 connector with a power supply tester**

Note

The —5V light in the figure is not lit. This is because the –5V wire (white) is optional. See Chapter 2 for more information on the individual pins in an ATX connection.

Note

Though it's uncommon, some proprietary computer's power supplies do not light specific voltages, for example the 3.3V light, even though the power supply is working properly. Check the documentation that came with the computer to see if this is an actual problem or a normal result.

3. Use a multimeter to test the power supply. Use the same methodology for testing with a multimeter as in the beginning of this chapter.
   a. Turn off the hard on/off switch. (If there is one; if not, unplug the IEC cord.)
   b. With the main motherboard connector (P1) inserted into the motherboard, connect the black lead to a ground wire (or other source of ground) and insert the red lead to a colored voltage wire in the main power connector, as shown in Figure 5.11. You need to dig a little bit to get the lead in there but don't press too hard. When the leads are stationary, move on to the next step.

FIGURE 5.11 **Testing the 3.3 volt wire with a multimeter set to volts DC**

   c. Turn on the hard on/off switch (or plug the IEC cord back in) and turn on the computer.

d. Turn on the multimeter to volts DC and view the results. In the figure you notice that we test an orange wire (which is rated for +3.3 volts). Generally, supply voltages should be within +/– 5 percent of the nominal value. Our result was +3.43 volts, which is within tolerance.

Note

If you have an analog multimeter, you would usually set this to 20 or higher. Just remember to move the decimal point in the reading for every increment higher than 20!

e. Shut off the multimeter and computer every time before moving to another wire. Check each of the wires for proper voltages. A chart of all the voltages for 20-pin and 24-pin connectors is available in Chapter 2.

f. If one of the wires fails or gives intermittent results, first verify you have a decent connection with the multimeter leads; then see if the wire just needs to be inserted into the main motherboard connector better, and if it continues, replace the power supply. If all the wires are fine (which is doubtful), move to the next step.

4. Swap the power supply with a known good power supply. Boot the computer and watch it for several minutes or longer to see if there are any strange and intermittent occurrences.

Remember that sometimes connections can be jarred loose inside and outside the computer. Check the IEC cord on both ends and all power connections inside the computer. This includes the main motherboard connector, Molex, mini, SATA, and PCIe connectors. Any one loose connector can have interesting results on your computer!

Heating and Cooling

Another thing to watch for is system overheating. This can happen for several reasons:

- Power supply fan failure
- Auxiliary case fan failure
- Inadequate amount of fans

- Missing or open slot covers
- Case isn't tightly closed and screwed in

Air flow is important on today's computers because processors can typically operate at 3 gflops. That creates a lot of heat. Add to that the fact that the video card and other cards have their own on-board processors, it can get hot inside the computer case. Circulation is the key word here. Air should flow in the case from the front and be exhausted out the back. Any openings in the case or missing slot covers can cause circulation to diminish. If you have a computer that has a lot of devices, or does a lot of processing, or runs hot for any other reason, your best bet is to install a case fan in the front of the case, which pulls air into the case, and a second case fan in the back of the case, which with the power supply fan helps to exhaust hot air out the back. Also, try to keep the computer in a relatively cool area and leave space for the computer to expel its hot air! Of course there are other special considerations and options, such as liquid cooling, and special processor cooling methods, such as the Intel Chassis Air Guide, but they are not covered in the A+ exam.

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

1. Which device tests multiple wires of a power supply at the same time?

❍ **A.** Multimeter
❍ **B.** Power supply tester
❍ **C.** Line conditioner
❍ **D.** Surge protector

2. Which power connector would be used to power an IDE hard drive?

❍ **A.** Molex
❍ **B.** mini
❍ **C.** P1
❍ **D.** P8/P9

3. Which of the following uses a 24-pin main motherboard power connector?

❍ **A.** ATX
❍ **B.** ATX 12V 1.3
❍ **C.** ATX 12V 2.0
❍ **D.** ATX 5V 2.0

4. The red wire in a Molex connection is rated for what voltage?

❍ **A.** 12 volts

❍ **B.** 5 volts

❍ **C.** 3.3 volts

❍ **D.** 24 volts

Cram Quiz Answers

1. **B**. The power supply tester tests 3.3V, 5V, –5V, 12V, and –12V simultaneously. A multimeter tests only one wire at a time. Line conditioners and surge protectors are preventative devices, not testing devices.

2. **A**. Molex connectors power IDE devices. Mini connectors are for floppy drives, P1 is a name used for the main motherboard connector, and P8/P9 are legacy main power connectors for AT systems.

3. **C**. ATX 12V 2.0 combined the 20-pin and 4-pin connectors used in ATX 12V 1.3 into one 24-pin connector.

4. **B.** The red wire is rated for 5 volts. The yellow wire is rated for 12 volts and 3.3 volts is associated with the main motherboard connector (to feed the processor); 24 volts is not involved in the devices we discussed in this chapter.

Additional Reading and Resources

Additional A+ resources: http://www.davidlprowse.com/aplus.

Mueller, Scott. *Upgrading and Repairing PCs*. Que. 2008.

Power Supply Calculator from Journey Systems:
http://www.journeysystems.com/?power_supply_calculator

Soper, Mark Edward; Mueller, Scott; Prowse, David L. *CompTIA A+ Certification Guide*. ISBN13: 9780789740472. Que.

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