CHAPTER 5

Supporting the Power System and Troubleshooting Computers

After completing this chapter, you will be able to:

- Describe the methods and devices for keeping a system cool
- Select a power supply to meet the power needs of a system
- Demonstrate an organized approach to solving any computer problem, especially hardware problems occurring during the boot
- Troubleshoot problems with the electrical system
- Troubleshoot problems with the motherboard, processor, and RAM
- Troubleshoot hardware problems with mobile devices

In the first chapters of this text, you learned much about the motherboard, processor, and RAM. This chapter focuses on how to keep these heat-producing components cool. You learn about the fans, heat sinks, and other devices needed to keep a system cool. You also learn about one more essential component of a computer system, the power supply, including how to select a power supply to meet the wattage needs of a system.

Then we focus on troubleshooting these various hardware subsystems and components. You study the troubleshooting techniques and procedures to get the full picture of what it's like to have the tools and knowledge in hand to solve any computer hardware-related problem. Then you learn to practically apply these skills to troubleshooting the electrical system, motherboard, processor, and memory. Finally, you learn about troubleshooting the hardware in mobile devices. By the end of this chapter, you should feel confident that you can face a problem with hardware and understand how to zero in on the source of the problem and its solution.

COOLING METHODS AND DEVICES

A+ 220-901 1.6

The processor, motherboard, memory modules, expansion cards, and other components in the case produce heat, and, if they get overheated, the system can get unstable and components can fail or be damaged. As a hardware technician, you need to know how to keep a system cool. Devices that are used to keep a system cool include CPU fans, case fans, coolers, heat sinks, and liquid cooling systems.

In this part of the chapter, you learn about these several methods to keep the system cool. We begin with keeping the processor cool.

PROCESSOR COOLERS, FANS, AND HEAT SINKS

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Because a processor generates so much heat, computer systems use a cooling assembly designed for a specific processor to keep temperatures below the processor maximum temperature. If a processor reaches its maximum temperature, it automatically shuts down. Good processor coolers maintain a temperature of 90–110 degrees F (32–43 degrees C). The **cooler** (see Figure 5-1) sits on top of the processor and consists of a fan and a heat sink. A **heat sink** is made of metal that draws the heat away from the processor into the fins. The fan can then blow the heat away. You learned to install a cooler in the chapter, "Supporting Processors and Upgrading Memory."

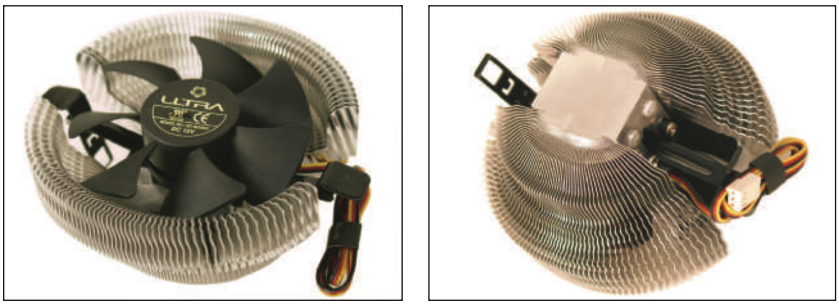

Figure 5-1 A cooler sits on top of a processor to help keep it cool

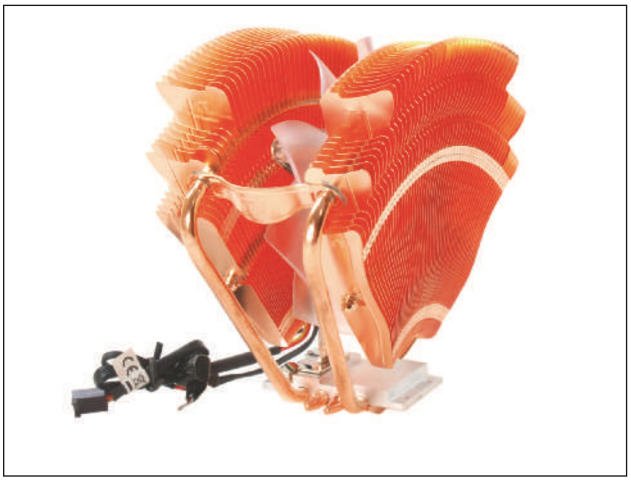

Figure 5-2 The Thermaltake V1 copper cooler fits Intel LGA1366 and LGA775 and AMD AM2 and AM2+ sockets

A cooler is made of aluminum, copper, or a combination of both. Copper is more expensive, but does a better job of conducting heat. For example, the Thermaltake (*www.thermaltake.com*) multisocket cooler shown in Figure 5-2 is made of copper and has an adjustable fan control.

Recall that the cooler is bracketed to the motherboard using a wire or plastic clip and thermal compound is placed between the bottom of the cooler heat sink and the top of the processor. To get its power, the cooler fan power cord connects to a 4-pin fan header on the motherboard (see Figure 5-3). The fan connector will have three or four holes. A three-hole connector can fit onto a 4-pin header; just ignore the last pin. A 4-pin header on the motherboard supports pulse width modulation (PWM) that controls fan speed in order to reduce the overall noise in a system. If you use a cooler fan power cord with three pins, know that the fan will always operate at the same speed.

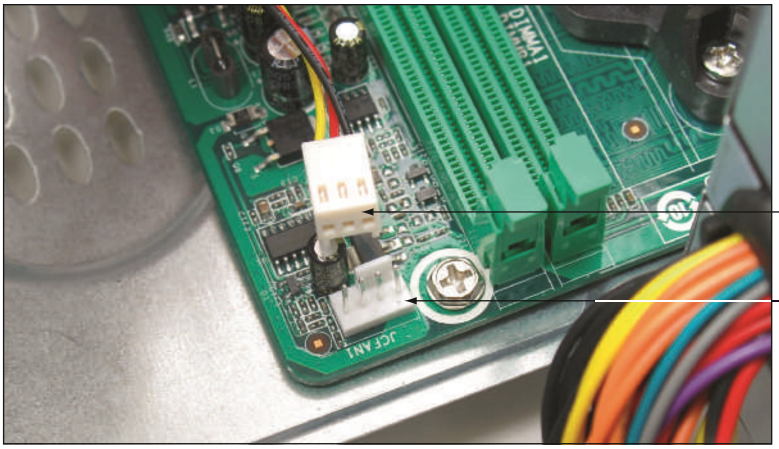

Figure 5-3 A cooler fan gets its power from a 4-pin PWM header on the motherboard

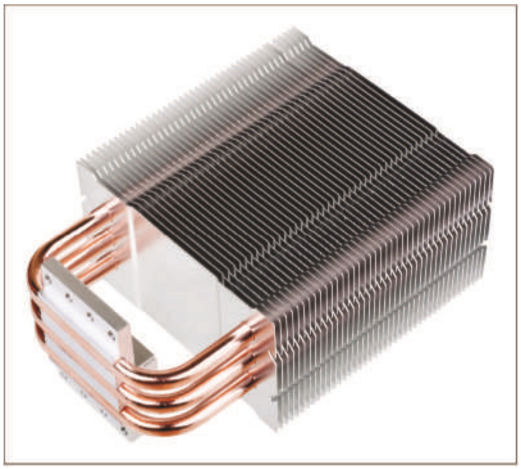

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Figure 5-4 A passive or fanless cooler uses heat pipes to dissipate heat from the CPU

For enthusiasts trying to run a desktop computer with less noise, a **fanless CPU cooler**, also called a **passive CPU cooler**, can help (see Figure 5-4). These coolers contain heat pipes, which contain a small amount of liquid that becomes a vapor when heated, and the vapor draws the heat away from the CPU toward the fins on the cooler. There the heat can be blown away by case fans. Most passive CPU coolers are very large, so before you buy one, be sure it will fit in your computer case with all other components installed. Also, most motherboards give a startup error if a cable is not attached to the CPU fan header. Because these coolers don't have a fan cable, you will need to attach another cable to the header. For some systems, you can connect a case fan to the header.

CASE FANS AND OTHER FANS AND HEAT SINKS

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To prevent overheating, you can also install additional case fans. Most cases have one or more positions on the case to hold a **case fan** to help draw air out of the case. Figure 5-5 shows holes on the rear of a case designed to hold a case fan.

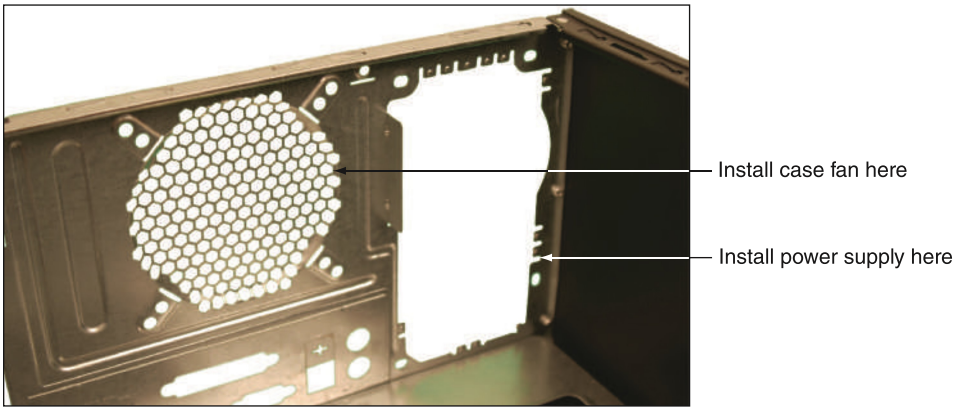
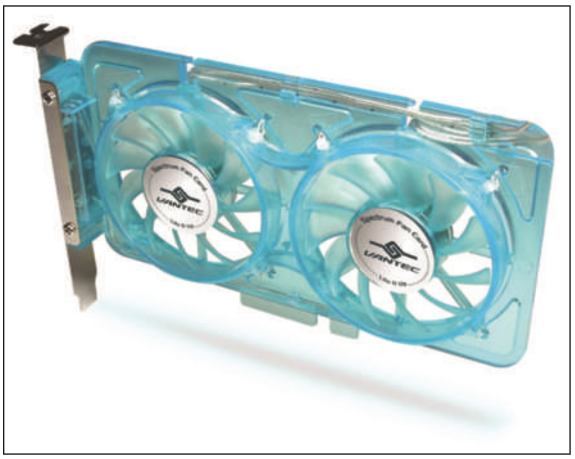


Figure 5-5 Install a case fan on the rear of this case to help keep the system cool

A computer case might need as many as seven or eight fans mounted inside the case; however, the trend is to use fewer and larger fans. Generally, large fans tend to perform better and run quieter than small fans.



Courtesy of Vantec Thermal Technologies

Figure 5-6 A PCI fan card by Vantec can be used next to a high-end graphics card to help keep it cool

Processors and video cards, also called graphics cards, are the two highest heat producers in a system. Some graphics cards come with a fan on the side of the card. You can also purchase heat sinks and fans to mount on a card to keep it cool. Another solution is to use a fan card mounted next to the graphics card. Figure 5-6 shows a PCI fan card. Be sure you select the fan card that fits the expansion slot you plan to use, and make sure there's enough clearance beside the graphics card for the fan card to fit.

For additional cooling, consider a RAM cooler such as the one shown in Figure 5-7. It clips over a DIMM. A fan might be powered by a SATA power connector or 4-pin Molex power connector. The fan shown in Figure 5-7 uses a Molex connector. You can use an adapter to convert a SATA or Molex connector to whichever the power supply provides.

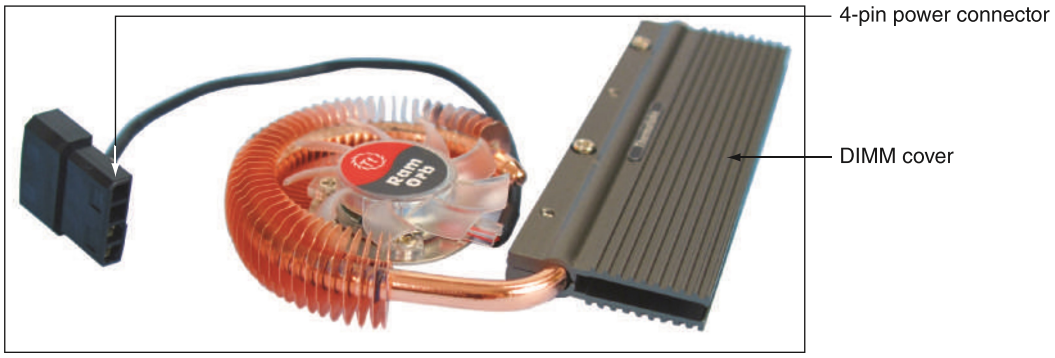


Figure 5-7 A RAM cooler keeps memory modules cool

When selecting any fan or cooler, take into consideration the added noise level and the ease of installation. Some coolers and fans can use a temperature sensor that controls the fan. Also consider the guarantee made by the cooler or fan manufacturer.

LIQUID COOLING SYSTEMS

A+ 220-901 1.6

In addition to using fans, heat sinks, and thermal compound to keep a processor cool, a liquid cooling system can be used. For the most part, they are used by hobbyists attempting to overclock to the max a processor in a gaming computer. For example, Intel recommends a liquid cooling system for processors that use the LGA2011 socket, which is typically used on hobbyist and gaming computers. (You learned about this socket in the chapter, "All About Motherboards.") Liquid cooling systems tend to run quieter than other cooling methods. They might include a PCIe or PCI card that has a power supply, temperature sensor, and processor to control the cooler.

Using liquid cooling, a small pump sits inside the computer case, and tubes move liquid around components and then away from them to a place where fans can cool the liquid, similar to how a car radiator works. Figure 5-8 shows one liquid cooling system where the liquid is cooled by fans sitting inside a large case. Sometimes, however, the liquid is pumped outside the case, where it is cooled.

Courtesy of Thermaltake (USA) Inc.

Figure 5-8 A liquid cooling system pumps liquid outside and away from components where fans can then cool the liquid

Figure 5-9 This case comes with a power supply, power cord, and bag of screws

Now let's turn our attention to the power supply.

SELECTING A POWER SUPPLY

A+ 220-901 1.2, 1.8

In the chapter, "Working Inside Desktop Computers and Laptops," you learned how to uninstall and install a power supply unit (PSU). Reasons you might need to replace a power supply are when a power supply fails, or the power supply in an existing system is not adequate for the system. When building a new system, you can purchase a computer case with the power supply already installed (see Figure 5-9), or you can purchase a power supply separate from the case.

TYPES AND CHARACTERISTICS OF POWER SUPPLIES

A+ 220-901 1.2, 1.8

As you select the right power supply for a system, you need to be aware of the following power supply features:

- *ATX or microATX form factor*. The form factor of a power supply determines the size of the power supply and the placement of screw holes and slots used to anchor the power supply to the case.
- *Wattage ratings*. A power supply has a wattage rating for total output maximum load (for example, 500 W, 850 W, or 1000 W) and individual wattage ratings for each of the voltage output circuits. These wattage capacities are listed in the documentation and on the side of a power supply, as shown in Figure 5-10.

Figure 5-10 Consider the number and type of power connectors and the wattage ratings of a power supply

When selecting a power supply, pay particular attention to the capacity for the +12 V rail. (A *rail* is the term used to describe each circuit provided by the power supply.) The +12 V rail is the most used, especially in high-end gaming systems. Notice in Figure 5-10, the +12 V rail gets 360 W of the maximum 525 W load. Sometimes you need to use a power supply with a higher-than-needed overall wattage to get enough wattage on this one rail. Also, a PSU rated 1000 W and higher might have a second +12 V rail and is called a **dual rail** power supply. The extra rail is used for safety to ensure that a single +12 V rail is not overloaded.

- *Number and type of connectors*. Consider the number and type of power cables and connectors the unit provides. Connector types are shown in Table 1-2 in the chapter, "First Look at Computer Parts and Tools." Table 5-1 lists some common connectors and the voltages they supply. Some power supplies include detached power cables that you can plug into connectors on the side of the unit. By using only the power cables you need, extra power cables don't get in the way of airflow inside the computer case.

Connector	Voltages	Description
SATA	+3.3 V, +5 V, +12 V	Power to SATA drives, 5 pin
Molex	+5 V, +12 V	Power to older IDE drives and used with some older SATA drives, 4 pin
4/8-pin 12 V	+12 V	Auxiliary power to CPU
PCIe 6/8 pin	+12 V	Auxiliary power to PCIe cards
20-pin P1	+3.3 V, ±5 V, ±12 V	Older main power connector to motherboard
24-pin P1	+3.3 V, ±5 V, ±12 V	Newer main power connector to motherboard

Table 5-1 Power supply connectors and voltages

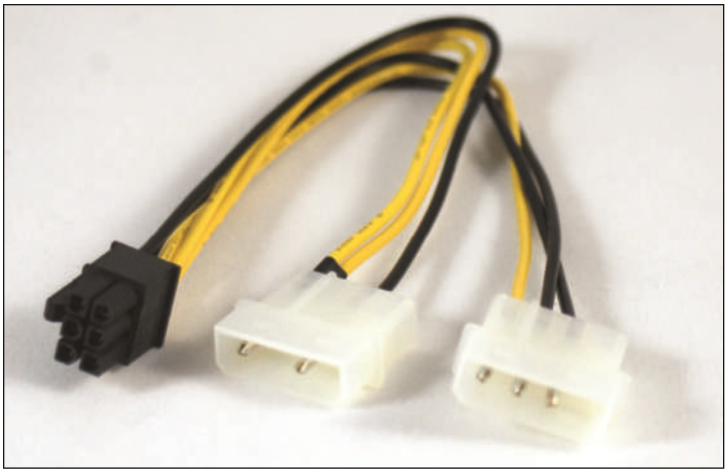


Figure 5-11 This adapter converts two Molex cables to a single 12 V 6-pin PCIe connector

A+ Exam Tip The A+ 220-901 exam expects you to know the voltage output of the power connectors listed in Table 5-1. Consider memorizing the table.

Notes If a power supply doesn't have the connector you need, it is likely you can buy an adapter to convert one connector to another. For example, Figure 5-11 shows an adapter that converts two Molex cables to one 12 V 6-pin PCIe connector.

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- *Fans inside the PSU*. Every power supply has a fan inside its case; some have two fans. The fan can be mounted on the back or top of the PSU. Fans range in size from 80mm to 150mm wide. The larger the fan, the better job it does and the quieter it runs. Some PSUs can automatically adjust the fan speed based on the internal temperature of the system.

Notes Some power supplies are designed without fans so that they can be used in home theater systems or other areas where quiet operation is a requirement.

- *Dual voltage options*. Expect a power supply to have a dual-voltage selector switch on the back where you can switch input voltage to 115 V for the United States or 220 V for other countries.
- *Extra features*. Consider the warranty of the power supply and the overall quality. Some power supplies are designed to support two video cards used in a gaming computer. Two technologies used for dual video cards are SLI by NVIDIA and Crossfire by AMD. If you plan to use dual video cards, use a PSU that supports SLI or Crossfire used by the video cards. Know that more expensive power supplies are quieter, last longer, and don't put off as much heat as less expensive ones. Also, expect a good power supply to protect the system against overvoltage. A power supply rated with Active PFC runs more efficiently and uses less electricity than other power supplies.

HOW TO CALCULATE WATTAGE CAPACITY

A+ 220-901 1.2, 1.8

When deciding what wattage capacity you need for the power supply, consider the total wattage requirements of all components inside the case as well as USB and FireWire devices that get their power from ports connected to the motherboard.

A+ Exam Tip The A+ 220-901 exam expects you to know how to select and install a power supply. You need to know how to decide on the wattage, connectors, and form factor of the power supply.

Keep these two points in mind when selecting the correct wattage capacity for a power supply:

- *Video cards draw the most power*. Video cards draw the most power in a system, and they draw from the +12 V output. If your system has a video card, pay particular attention to the +12 V rating.

The current trend is for the motherboard to provide the video components and video port, thus reducing the overall wattage needs for a system. Video cards are primarily used in gaming computers or other systems that require high-quality graphics.

- ***The power supply should be rated about 30 percent higher than expected needs.*** Power supplies that run at less than peak performance last longer and don't overheat. In addition, a power supply loses some of its capacity over time. Also, don't worry about a higher-rated power supply using too much electricity. Components only draw what they need. For example, a power supply rated at 1000 W and running at a 500 W draw will last longer and give off less heat than a power supply rated at 750 W and running at a 500 W draw.

To know what size power supply you need, add up the wattage requirements of all components, and add 30 percent. Technical documentation for these components should give you the information you need. Table 5-2 lists appropriate wattage ratings for common devices. Alternately, you can use a wattage calculator provided on the website of many manufacturers and vendors. Using the calculator, you enter the components in your system and then the calculator will recommend the wattage you need for your power supply.

Devices	Approximate Wattage
Motherboard, processor, memory, keyboard, and mouse	200–300 W
Fan	5 W
SATA hard drive	15–30 W
DVD/CD drive	20–30 W
PCI video card	50 W
PCI card (network card, FireWire card, or other PCI card)	20 W
PCIe ×16 video card	150–300 W
PCIe ×16 card other than a video card	100 W

Table 5-2 To calculate the power supply rating you need, add up total wattage

Caution Some older Dell motherboards and power supplies do not use the standard P1 pinouts for ATX, although the power connectors look the same. For this reason, never use a Dell power supply with a non-Dell motherboard, or a Dell motherboard with a non-Dell power supply, without first verifying that the power connector pinouts match; otherwise, you might destroy the power supply, the motherboard, or both.

Table 5-3 lists a few case and power supply manufacturers.

Manufacturer	Website
Antec	*www.antec.com*
Cooler Master	*www.coolermaster.com*
EVGA	*www.evga.com*
FirePower Technology	*www.firepower-technology.com*
Rosewill	*www.rosewill.com*
Sentey	*www.sentey.com*
Silverstone	*www.silverstonetek.com*
Thermaltake	*www.thermaltakeusa.com*
Zalman	*www.zalman.com*

Table 5-3 Manufacturers of cases and power supplies for personal computers

Hands-On Project 5-1 Calculate Wattage Capacity for Your System

A+ 220-901 1.8

Do the following to compare the wattage capacity of the power supply installed in your computer with the recommended value:

1. Search the web for a power supply wattage calculator. Be sure the one you use is provided by a reliable website. For example, the ones at *newegg.com* and *extreme.outervision.com* are reliable. (At *newegg.com*, click **Computer Hardware** and then click **Power Supply Wattage Calculator**. At *extreme.outervision.com*, click **eXtreme Power Supply Calculator**.)
2. Enter the information about your computer system. Print or save the webpage showing the resulting calculations.
3. What is the recommended wattage capacity for a power supply for your system?
4. Look on the printed label on the power supply currently installed in your computer. What is its wattage capacity?
5. If you had to replace the power supply in your system, what wattage capacity would you select?

Hands-On Project 5-2 Shop for a Power Supply

A+ 220-901 1.8

Shop online for a power supply to meet the needs of each of the following systems. Print or save the webpage showing the power supply, its features, and its price:

1. A regular desktop system for light computing has a moderately priced motherboard and processor, onboard video, two SATA hard drives, a DVD-RW drive, and two case fans. The system needs a microATX power supply rated at least 450 W.
2. A file server has a high-end motherboard and processor using the LGA2011 socket, 8 modules of DDR4 RAM, onboard video, one SSD SATA hard drive, five magnetic SATA hard drives, DVD-RW drive, tape drive, PCI RAID card, and four fans. The system needs an ATX power supply rated at about 550 W.
3. A gaming system has a high-end motherboard and processor, two high-end video cards using SLI technology, two SATA hard drives, a Blu-ray drive, and four fans. The system needs an ATX power supply rated at about 800 W. The two high-end video cards require about 275 W each.
4. Suppose the gaming system in Number 3 is generating extra heat because of overclocking and a liquid cooling system has been installed. To account for the needs of the liquid cooling system, the power supply needs to be upgraded to 1800 W.

So far in the text, you have learned about motherboards, processors, RAM, and the electrical system, which are the principal hardware components of a computer. With this hardware foundation in place, you're ready to learn about computer troubleshooting. Let's start with an overview of how to approach any hardware problem, and then we'll turn our attention to the details of troubleshooting the electrical system, motherboard, RAM, and CPU.

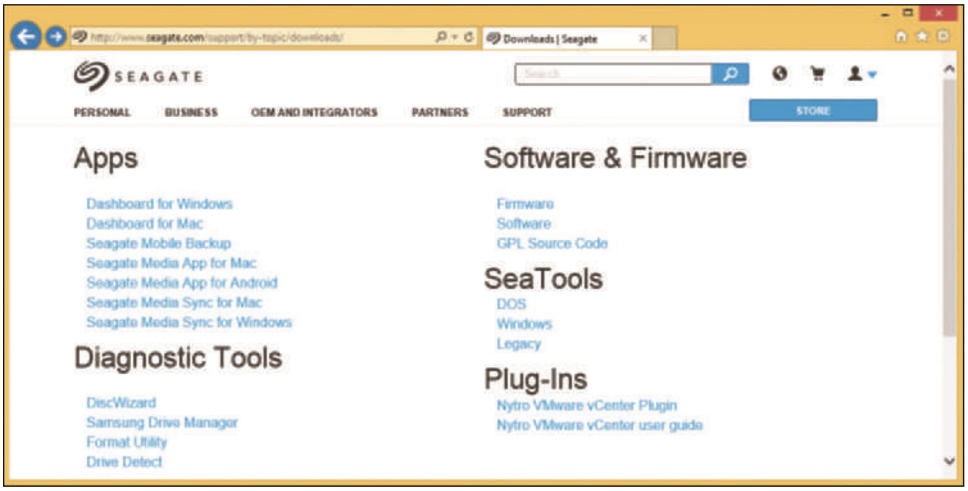
HOW TO APPROACH A HARDWARE PROBLEM

A+ 220-901 3.0, 4.1

A good IT support technician over time builds a strong network of resources he or she can count on when solving computer problems. Here are some resources to help you get started with your own list of reliable and time-tested sources of help:

- ***The web***. Do a web search on an error message, short description of the problem, or model and manufacturer of a device to get all sorts of help on the web. Check out the website of the product manufacturer or search a support forum. It's likely that others have encountered the same problem and posted the question and answer. If you search and cannot find your answer, you can post a new question. *Youtube.com* videos might help. Many technicians enjoy sharing what they know online, but be careful, however. Not all technical advice is correct or well intentioned.
- ***Chat, forums, or email technical support***. Support from the hardware and software manufacturers can help you interpret an error message or provide general support in diagnosing a problem. Most technical support is available during working hours by way of an online chat session.
- ***Manufacturer's diagnostic software***. Many hardware device manufacturers provide diagnostic software, which is available for download from their websites. For example, you can download Diagnostic Tools (can be used to copy all data from a drive that won't boot to another device), SeaTools for Windows (must be installed in Windows), or SeaTools for DOS (used to create a bootable CD that contains the software) and use the software to diagnose problems with Seagate and Maxtor drives. See Figure 5-12. Search the support section of a manufacturer's website to find diagnostic software and guidelines for using it.

Notes Always check compatibility between utility software and the operating system you plan to use.



Source: www.seagate.com

Figure 5-12 Download diagnostic software tools from a manufacturer's website

- ***User manuals***. Refer to your user manuals, which often list error messages and their meanings. They also might contain a troubleshooting section and list any diagnostic tools available.
- ***Technical associates in your organization can help***. Be sure to ask for advice when you're stuck. Also, after making a reasonable and diligent effort to resolve a problem, getting the problem fixed could become more important than resolving it yourself. There comes a time when you might need to turn the problem over to a more experienced technician. (In an organization, this process is called escalating the problem.)

Next, let's examine the six-step model for computer troubleshooting. You'll learn much more about these steps in later chapters. Keep in mind, however, that these steps are only the beginning of computer troubleshooting. As an IT technician, expect that you will build your own style and steps for troubleshooting based on your own experiences over time.

STEP 1: INTERVIEW THE USER

A+ 220-901 4.1

When an end user brings any computer problem to you, begin the troubleshooting process by interviewing the user. When you interview the user, you might want to include these questions:

- Can you describe the problem and describe when the problem first started and when it occurs?
- Was the computer recently moved?
- Was any new hardware or software recently installed?
- Was any software recently reconfigured or upgraded?
- Did someone else use your computer recently?
- Does the computer have a history of similar problems?
- Is there important data on the drive that is not backed up?
- Can you show me how to reproduce the problem?

After you gather this basic information, you can prioritize what to do and begin diagnosing and addressing the problem. If the computer will not start or starts with errors so that you cannot reach the Windows desktop, setting priorities helps focus your work. For most users, data is the first priority unless they have a recent backup.

STEP 2: BACK UP DATA AS NEEDED

A+ 220-901 4.1

If the hard drive has important data on it that has not been backed up, your first priority is most likely to recover the data. Here are three options for doing that:

- ***Move the hard drive to another system.*** If a system won't boot from the hard drive, consider removing the drive and installing it as a second drive in a working system. If the file system on the problem drive is intact, you might be able to copy data from the drive to the primary drive in the working system.

To move the hard drive to a working computer, you don't need to physically install the drive in the drive bay. Open the computer case. Carefully lay the drive on the case and connect a power cord and data cable (see Figure 5-13). Then turn on the computer. While you have the computer turned on, be *very careful* to not touch the drive or touch inside the case. Also, while a tower case is lying on its side like the one in Figure 5-13, don't use the optical drive.

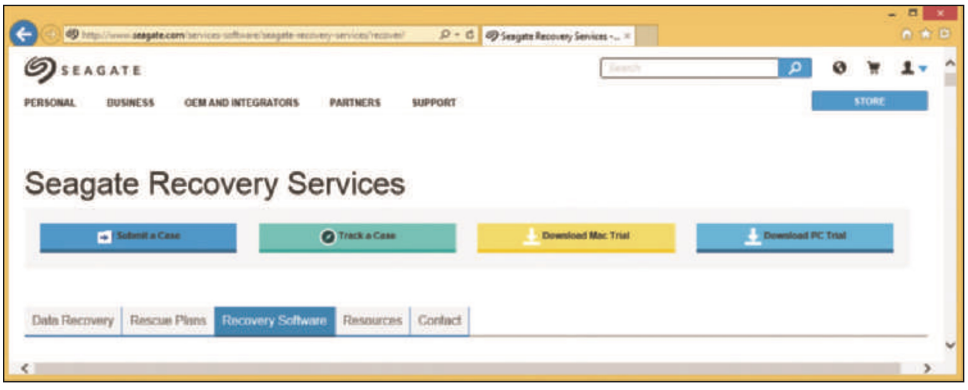
Figure 5-13 Move a hard drive to a working computer to recover data on the drive

Start the computer and sign in to Windows using an Administrator account. (If you don't sign in with an Administrator account, you must provide the password to an Administrator account before you can access the files on the newly connected hard drive.) When Windows finds the new drive, it assigns it a drive letter. Use Explorer in Windows 8/7/Vista or third-party software to copy files from this drive to the primary hard drive in this system or to another storage media. Then return the drive to the original system and turn your attention to solving the original problem.

Notes An easier way to temporarily install a hard drive in a system is to use a USB port. Figure 5-14 shows a SATA-to-USB converter kit. The SATA connector can be used for desktop or laptop hard drives because a SATA connector is the same for both. A SATA-to-USB converter is really handy when recovering data and troubleshooting problems with hard drives that refuse to boot.

Figure 5-14 Use a USB-to-SATA converter to recover data from a drive using a SATA connector

- *Use file recovery software.* File recovery software is third-party software that can help recover deleted and corrupted files. On the Internet, do a search on "data recovery" for lots of examples. One good product is GetDataBack by Runtime Software (*www.runtime.org*), which can recover data and program files even when Windows cannot recognize the drive. Another example is Seagate Recovery Services (see Figure 5-15), which includes various tools and services, including file recovery software PC Trial.



Source: www.seagate.com

Figure 5-15 File recovery software made available by Seagate, a hard drive manufacturer

- *Hire a professional file recovery service.* If your data is extremely valuable and other methods have failed, you might want to consider a professional data recovery service. They're expensive, but getting the data back might be worth it. To find a service, do a web search on "data recovery." Before selecting a service, be sure to read reviews, understand the warranty and guarantees, and perhaps get a recommendation from a satisfied customer. For example, in Figure 5-15, click **Data Recovery** to see a description of the service offered by Seagate.

STEP 3: EXAMINE THE SYSTEM AND ESTABLISH A THEORY

A+ 220-901 4.1

After data is secure, you're ready to tackle the problem and its solution. Most computer problems are simple and can be simply solved, but you do need a game plan. That's how Figure 5-16 can help. The flowchart focuses on problems that affect the boot. As you work your way through it, you're eliminating one major computer subsystem after another until you zero in on the problem. After you've discovered the problem, many times the solution is obvious.

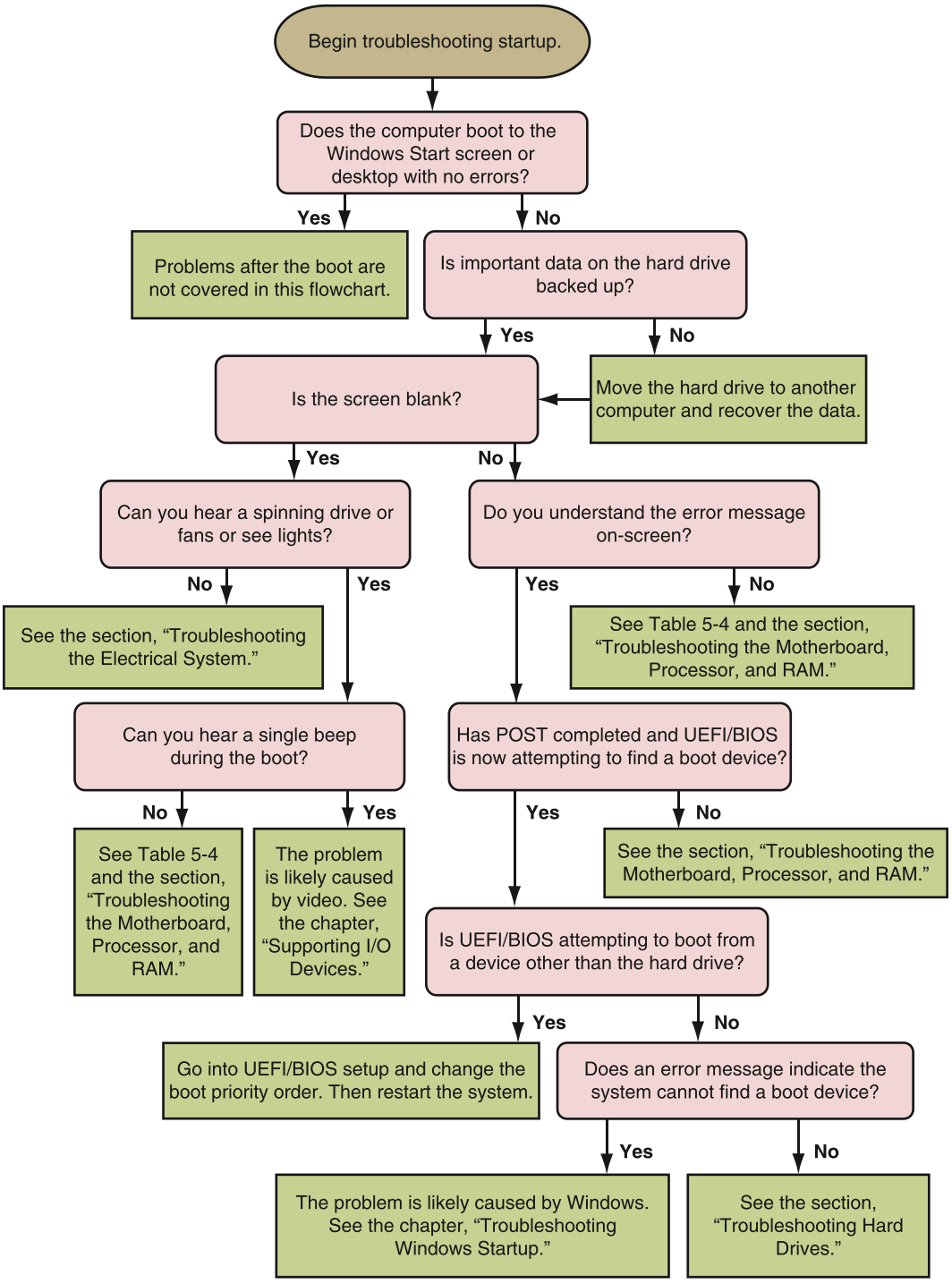


Figure 5-16 Use this flowchart when first facing a computer problem

As Figure 5-16 indicates, troubleshooting a computer problem is divided into problems that occur during the boot and those that occur after the Windows Start screen or desktop has successfully loaded. Problems that occur during the boot might happen before Windows starts to load or during Windows startup. Read the flowchart in Figure 5-16 very carefully to get an idea of the symptoms you might be faced with that would cause you to suspect each subsystem.

Also, Table 5-4 can help as a general guideline for the primary symptoms and what are likely to be the sources of a problem.

A+ Exam Tip The A+ 220-902 exam might give you a symptom and expect you to select a probable source of a problem from a list of sources. These examples of what can go wrong can help you connect problem sources to symptoms.

Symptom or Error Message	What to Do About the Problem
System shuts down unexpectedly	Try to find out what was happening at the time of the shutdowns to pinpoint an application or device causing the problem. Possible sources of the problem are overheating or faulty RAM, motherboard, or processor.
System shuts down unexpectedly and starts back up	Begin by checking the system for overheating. Is the processor cooler fan working? Go to UEFI/BIOS setup and check the temperature of the processor. When the processor overheats and the system restarts, the problem is called a processor thermal trip error.
System locks up with an error message on a blue screen, called a blue screen of death (BSOD)	Figure 5-17 shows an example of a BSOD error screen. These Windows errors are caused by problems with devices, device drivers, or a corrupted Windows installation. Begin troubleshooting by searching the Microsoft website for the error message and a description of the problem.
System locks up with an error message on a black screen	These error messages, such as the one shown in Figure 5-18, are most likely caused by an error at POST. Begin by troubleshooting the device mentioned in the error message.
System freezes or locks up without an error message	If the system locks up without an error screen and while still displaying the Windows Start screen or desktop, the problem is most likely caused by an application not responding. Sometimes you'll see the Windows pinwheel indicating the system is waiting for a response from a program or device. Open the Windows Task Manager utility and end any application that is not responding. If that doesn't work, restart Windows.
POST code beeps	One or no beep indicates that all is well after POST. However, startup UEFI/BIOS communicates POST errors as a series of beeps before it tests video. Search the website of the motherboard or UEFI/BIOS manufacturer to know how to interpret a series of beep codes. You might need to restart the system more than once so you can carefully count the beeps. Table 5-5 lists some common beep codes.
No power	If you see no lights on the computer case and hear no spinning fans, make sure the surge protector or wall outlet has power. Is the switch on the rear of the case on? Is the dual voltage selector switch set correctly? Are power supply connectors securely connected? Is the power supply bad?
Blank screen when you first power up the computer, and no noise or indicator lights	Is power getting to the system? If power is getting to the computer, address the problem as an electrical problem with the computer. Make sure the power supply is good and power supply connectors are securely connected.
Blank screen when you first power up the computer, and you can hear the fans spinning and see indicator lights	Troubleshoot the video subsystem. Is the monitor turned on? Is the monitor data cable securely connected at both ends? Is the indicator light on the front of the monitor on?
BIOS loses its time and date settings "CMOS battery low" error message appears during the boot	The CMOS battery is failing. Replace the battery.
System reports less memory than you know is installed	A memory module is not seated correctly or has failed. Begin troubleshooting memory.

Table 5-4 Symptoms or error messages caused by hardware problems and what to do about them (continues)

Symptom or Error Message	What to Do About the Problem
System attempts to boot to the wrong boot device	Go into UEFI/BIOS setup and change the boot device priority order.
Fans spin, but no power to other devices	Begin by checking the power supply. Are connectors securely connected? Use a power supply tester to check for correct voltage outputs.
Smoke or burning smell	Consider this a serious electrical problem. Immediately unplug the computer.
Loud whining noise	Most likely the noise is made by the power supply or a failing hard drive. There might be a short. The power supply might be going bad or is underrated for the system.
Clicking noise	A clicking noise likely indicates the hard drive is failing. Replace the drive as soon as possible.
Intermittent device failures	Failures that come and go might be caused by overheating or failing RAM, the motherboard, processor, or hard drive. Begin by checking the processor temperature for overheating. Then check RAM for errors and run diagnostics on the hard drive.
Distended capacitors	Failed capacitors on the motherboard or other circuit board are sometimes distended and discolored on the top of the capacitor. Replace the motherboard.
Error appears during boot: *Intruder detection error*	An intrusion detection device installed on the motherboard has detected that the computer case was opened. Suspect a security breach.
Error appears during boot: *Overclocking failed. Please enter setup to reconfigure your system*	Overclocking should be discontinued. However, this error might not be related to overclocking; it can occur when the power supply is failing.
Possible error messages: *No boot device available* *Hard drive not found* *Fixed disk error* *Invalid boot disk* *Inaccessible boot device or drive* *Invalid drive specification*	Startup BIOS did not find a device to use to load the operating system. Make sure the boot device priority order is correct in BIOS setup. Then begin troubleshooting the hard drive.
Possible error messages: *Missing operating system* *Error loading operating system*	Windows startup programs are missing or corrupted. How to troubleshoot Windows startup is covered in the chapter, "Troubleshooting Windows Startup."
Continuous reboots	See explanation later in this chapter.

Table 5-4 Symptoms or error messages caused by hardware problems and what to do about them (continued)

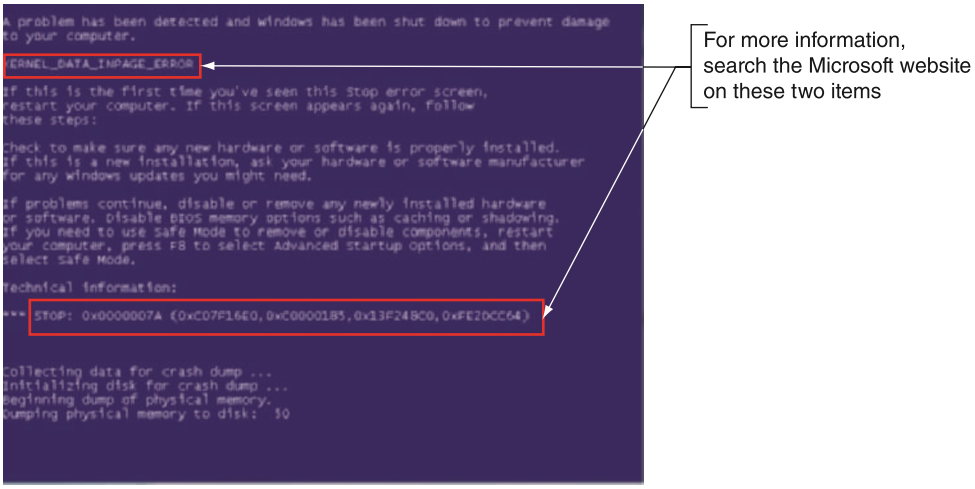
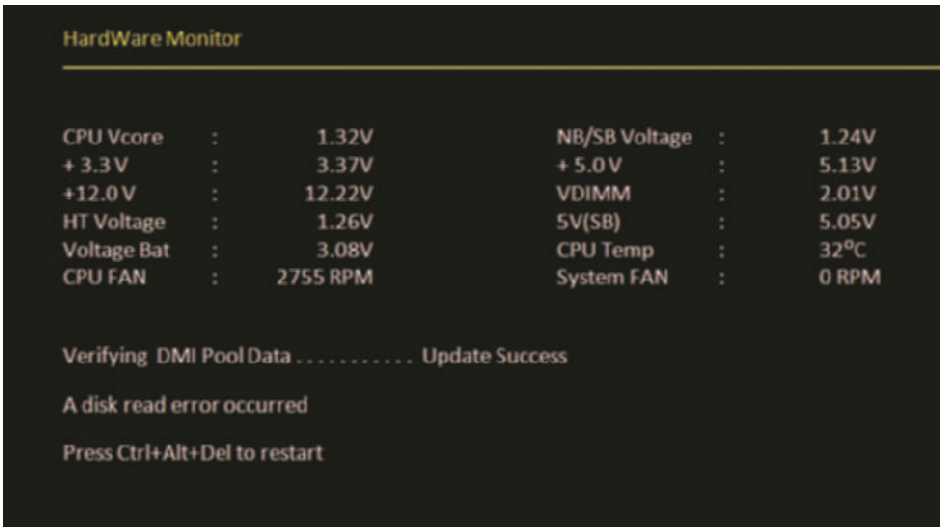


Figure 5-17 Search the Microsoft website for information about a BSOD error



Source: Intel

Figure 5-18 A POST error message on a black screen shown early in the boot

Beeps During POST	Description
1 short beep or no beep	The computer passed all POST tests
1 long and 2 short beeps	Award BIOS: A video problem, no video card, bad video memory Intel BIOS: A video problem
Continuous short beeps	Award BIOS: A memory error Intel BIOS: A loose card or short
1 long and 1 short beep	Intel BIOS: Motherboard problem
1 long and 3 short beeps	Intel BIOS: A video problem
3 long beeps	Intel BIOS: A keyboard controller problem
Continuous 2 short beeps and then a pause	Intel BIOS: A video card problem
Continuous 3 short beeps and then a pause	Intel BIOS: A memory error
8 beeps followed by a system shutdown	Intel BIOS: The system has overheated
Continuous high and low beeps	Intel BIOS: CPU problem

Table 5-5 Common beep codes and their meanings for Intel and Award BIOS

APPLYING CONCEPTS FOUR TROUBLESHOOTING RULES

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Here are four important rules that can help you solve many hardware problems:

Rule 1: Check the Obvious and Check Simple Things First

Check for obvious and simple solutions first. Here are some tips:

- Is the external device plugged in and turned on? Are the data cable connections solid at both ends? Is there a wall light switch controlling the power, and is it turned on? Is the surge suppressor you're using plugged in and turned on?
- For expansion cards and memory modules, are they seated solidly in their slots? For sound, is the volume knob turned up? For video, is the monitor getting power, turned on, connected, and is the screen resolution correct?

- Consider the application using the device. For example, if you are having problems trying to use a USB scanner, try scanning using a different application.

Rule 2: Trade Known Good for Suspected Bad

When diagnosing hardware problems, this method works well if you can draw from a group of parts that you know work correctly. Suppose, for example, video does not work. The parts of the video subsystem are the video card, the power cord to the monitor, the cord from the monitor to the computer case, and the monitor itself. Also, don't forget that the video card is inserted into an expansion slot on the motherboard, and the monitor depends on electrical power. As you suspect each of these five components to be bad, you can try them one at a time beginning with the easiest one to replace: the monitor. Trade the monitor for one that you know works. If this theory fails, trade the power cord, trade the cord to the computer's video port, move the video card to a new slot, and trade the video card. When you're trading a good component for a suspected bad one, work methodically by eliminating one component at a time.

Rule 3: Trade Suspected Bad for Known Good

An alternate approach works well in certain situations. If you have a working computer that is configured similarly to the one you are troubleshooting (a common situation in many corporate or educational environments), rather than trading good for suspected bad, you can trade suspected bad for good. Take each component that you suspect is bad and install it in the working computer. If the component works on the good computer, then you have eliminated it as a suspect. If the working computer breaks down, then you have probably identified the bad component.

Rule 4: Divide and Conquer

Isolate the problem. In the overall system, remove one hardware or software component after another, until the problem is isolated to a small part of the whole system. As you divide a large problem into smaller components, you can analyze each component separately. You can use one or more of the following to help you divide and conquer on your own system:

- In Windows, stop all nonessential services running in the background to eliminate them as the problem.
- Boot from a bootable DVD to eliminate the OS and startup files on the hard drive as the problem.
- Remove any unnecessary hardware devices, such as a second video card, optical drive, and even the hard drive.

Once down to the essentials, start exchanging components you know are good for those you suspect are bad, until the problem goes away. You don't need to physically remove the optical drive or hard drive from the bays inside the case. Simply disconnect the data cable and the power cable.

STEPS 4, 5, AND 6: FIX THE PROBLEM, VERIFY THE FIX, AND DOCUMENT THE OUTCOME

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After you understand the problem, you're ready to plan steps to resolve the problem. After the fix, be sure to verify the system works. Perform one last hard boot and make sure everything works as expected. If you're working with a user, ask the user to also verify the problem is fixed. In addition, ask yourself if anything could have been done to prevent the problem from happening in the first place. If so, take preventive action. Finally, most organizations require troubleshooting a computer problem be documented in a call tracking or help desk application where you are expected to record your findings, actions, and outcomes. Throughout the rest of this text, you'll have many opportunities to practice the troubleshooting skills introduced here.

Hands-On Project 5-3 Research Beep Codes

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Identify the motherboard and UEFI/BIOS version installed in your computer. Locate the motherboard user guide on the web and find the list of beep codes that the UEFI/BIOS might give at POST. If the manual doesn't give this information, search the support section on the website of the motherboard manufacturer or search the website of the UEFI/BIOS manufacturer. List the beep codes and their meanings for your motherboard.

SPECIAL CONCERNS WHEN TROUBLESHOOTING MOBILE DEVICE HARDWARE

A+ 220-901 3.0

When a component on a laptop or other mobile device needs replacing or upgrading, first you need to consider the warranty and how much time the repair will take. Before you decide to upgrade or repair an internal component, take into consideration these three alternatives:

- ***Return the mobile device to the manufacturer or another service center for repair.*** If the mobile device is under warranty, you need to return it to the manufacturer to do any serious repair work such as fixing a broken LCD panel on a laptop. However, for simple repair and upgrade tasks, such as upgrading memory or exchanging a hard drive on a laptop, most likely you can do these simple jobs by yourself without concern for voiding a warranty. Manufacturers allow a user to exchange the hard drive or memory when these components are accessible by way of a door or cover on the bottom of the laptop and it's not necessary to open the case. If you're not sure about the possibility of voiding the warranty, check with the manufacturer before you begin working on the mobile device. If the device is not under warranty and you don't have the experience or time to fix a broken component, find out how much the manufacturer will charge to do the job. Also, consider taking the device to a mobile device repair shop. Know that some mobile device manufacturers refuse to sell internal components or service manuals that explain how to take the device apart except to authorized service centers. In this case, you have few options but to use the authorized service center for repairs.

Caution Before you send a laptop or other device for repairs, if possible, back up any important data on the device. It's possible the service center will format the hard drive or install a new drive on a laptop or do a factory reset for a mobile device.

- ***Substitute an external component for an internal component.*** Replacing components on mobile devices can be time consuming and require a lot of patience. For a laptop, consider using BIOS setup to disable an internal component and then use an external device in its place. For example, if a keyboard fails, you can use a wireless keyboard with an access point connected to the USB port. Also, if the Ethernet port fails, the simplest solution might be to disable the port and use a USB network adapter to provide the Ethernet port.
- ***Replace the internal device.*** Before deciding to replace an internal device that is not easy to get to, such as an LCD panel in a laptop, first find out if you can get the manufacturer documentation necessary to know how to open the laptop case and exchange the component. Also consider if the cost of parts and labor is worth more than the value of the device. Buying a new device might be the best solution for your customer.

Notes Check out *www.ifixit.com* for directions for device teardowns and repairs. You can also buy on the site the specific tools you might need for a teardown.

Now you're ready to look at how to troubleshoot each subsystem that is critical to booting up the computer. We begin with the electrical system.

TROUBLESHOOTING THE ELECTRICAL SYSTEM

APPLYING | CONCEPTS

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Your friend Sharon calls to ask for your help with a computer problem. Her system has been working fine for over a year, but now strange things are happening. Sometimes the system powers down for no apparent reason while she is working, and sometimes Windows locks up. As you read this section, look for clues as to what the problem might be. Also, as you read, think of questions to ask your friend that will help you diagnose the problem.

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Electrical problems can occur before or after the boot and can be consistent or intermittent. Many times repair technicians don't recognize the cause of a problem to be electrical because of the intermittent nature of some electrical problems. In these situations, the hard drive, memory, the OS, or even user error might be suspected as the source of the problem and then systematically eliminated before the electrical system is suspected. This section will help you to be aware of symptoms of electrical problems so that you can zero in on the source of an electrical problem as quickly as possible.

Possible symptoms of a problem with the electrical system are:

- The computer appears "dead"—no indicator lights and no spinning drive or fan.
- The computer sometimes locks up during booting. After several tries, it boots successfully.
- Error codes or beeps occur during booting, but they come and go.
- You smell burnt parts or odors. (Definitely not a good sign!)
- The computer powers down at unexpected times.
- The computer appears dead, but you hear a whine coming from the power supply.

Without opening the computer case, the following list contains some questions you can ask and things you can do to solve a problem with the electrical system. The rule of thumb is "try the simple things first." Most computer problems have simple solutions.

- If you smell any burnt parts or odors, don't try to turn the system on. Identify the component that is fried and replace it.
- When you first plug up power to a system and hear a whine coming from the power supply, the power supply might be inadequate for the system or there might be a short. Don't press the power button to start up the system. Unplug the power cord so that the power supply will not be damaged. The next step is to open the case and search for a short. If you don't find a short, consider upgrading the power supply.
- Is the power cord plugged in? If it is plugged into a power strip or surge suppressor, is the device turned on and also plugged in?
- Is the power outlet controlled by a wall switch? If so, is the switch turned on?
- Are any cable connections loose?
- Is the circuit breaker blown? Is the house circuit overloaded?
- Are all switches on the system turned on? Computer? Monitor? Surge suppressor or UPS (uninterruptible power supply)?
- Is there a possibility the system has overheated? If so, wait a while and try again. If the system comes on, but later turns itself off, you might need additional cooling fans inside the unit. How to solve problems with overheating is covered later in this chapter.
- Older computers might be affected by electromagnetic interference (EMI). Check for sources of electrical or magnetic interference such as fluorescent lighting or an electric fan or copier sitting near the computer case.

Caution Before opening the case of a brand name computer, such as a Gateway or Dell, consider the warranty. If the system is still under warranty, sometimes the warranty is voided if the case is opened. If the warranty prevents you from opening the case, you might need to return the system to a manufacturer's service center for repairs.

If the problem is still not solved, it's time to look inside the case. First, turn off the computer, unplug it, press the power button to drain residual power, and then open the case. Next, do the following:

- Check all power connections from the power supply to the motherboard and drives. Also, some cases require the case's front panel be in place before the power-on button will work. Are all cards securely seated?
- If you smell burnt parts, carefully search for shorts and frayed and burnt wires. Disassemble the parts until you find the one that is damaged.
- If you suspect the power supply is bad, test it with a power supply tester.

PROBLEMS THAT COME AND GO

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If a system boots successfully to the Windows Start screen or desktop, you still might have a power system problem. Some problems are intermittent; that is, they come and go. Generally, intermittent problems are more difficult to solve than a dead system. There can be many causes of intermittent problems, such as an inadequate power supply, overheating, and devices and components damaged by ESD. Here are some symptoms that might indicate an intermittent problem with the electrical system after the boot:

- The computer stops or hangs for no reason. Sometimes it might even reboot itself.
- Memory errors appear intermittently.
- Data is written incorrectly to the hard drive.
- The keyboard stops working at odd times.
- The motherboard fails or is damaged.
- The power supply overheats and becomes hot to the touch.
- The power supply fan whines and becomes very noisy or stops.

Here is what to do to eliminate the electrical system as the source of an intermittent problem:

1. ***Consider the power supply is inadequate.*** If the power supply is grossly inadequate, it will whine when you first plug up the power. If you have just installed new devices that are drawing additional power, verify the wattage rating of the power supply is adequate for the system.

   You can also test the system to make sure you don't have power problems by making all the devices in your system work at the same time. For instance, you can make two hard drives and the DVD drive work at the same time by copying files from one hard drive to the other while playing a movie on the DVD. If the new drive and the other drives each work independently, but data errors occur when all work at the same time, suspect a shortage of electrical power.

2. ***Suspect the power supply is faulty.*** You can test it using either a power supply tester (the easier method) or a multimeter (the more tedious method). However, know that a power supply that gives correct voltages when you measure it might still be the source of problems because power problems can be intermittent. Also be aware that an ATX power supply monitors the range of voltages provided to the motherboard and halts the motherboard if voltages are inadequate. Therefore, if the power supply appears "dead," your best action is to replace it.

3. ***The power supply fan might not work.*** Don't operate the computer if the fan does not work because computers without cooling fans can quickly overheat. Usually just before a fan stops working, it hums or whines, especially when the computer is first turned on. If this has just happened, replace the power supply. After you replace the power supply, if the new fan does not work, you have to dig deeper to find

the source of the problem. You can now assume the problem wasn't the original fan. A short somewhere else in the system drawing too much power might cause the problem. To troubleshoot a nonfunctional fan, which might be a symptom of another problem and not a problem of the fan itself, follow these steps:

a. Turn off the power and remove all power cord connections to all components except the motherboard. Turn the power back on. If the fan works, the problem is with one of the systems you disconnected, not with the power supply, the fan, or the motherboard.

b. Turn off the power and reconnect one card or drive at a time until you identify the device with the short.

c. If the fan does not work when all devices except the motherboard are disconnected, the problem is the motherboard or the power supply. Because you have already replaced the power supply, you can assume the problem is the motherboard and it's time to replace it.

POWER PROBLEMS WITH THE MOTHERBOARD

A+ 220-901 4.1

A short might occur if some component on the motherboard makes improper contact with the chassis. This short can seriously damage the motherboard. For some cases, check for missing standoffs (small plastic or metal spacers that hold the motherboard a short distance away from the bottom of the case). A missing standoff most often causes these improper connections. Also check for loose standoffs or screws under the board that might be touching a wire on the bottom of the board and causing a short.

Shorts in the circuits on the motherboard might also cause problems. Look for damage on the bottom of the motherboard. These circuits are coated with plastic, and quite often damage is difficult to spot. Also look for burned-out capacitors that are spotted brown or corroded. You'll see examples of burned-out capacitors later in the chapter.

APPLYING | CONCEPTS

Back to Sharon's computer problem. Here are some questions that will help you identify the source of the problem:

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- Have you added new devices to your system? (These new devices might be drawing too much power from an overworked power supply.)
- Have you moved your computer recently? (It might be sitting beside a heat vent or electrical equipment.)
- Does the system power down or hang after you have been working for some time? (This symptom might have more than one cause, such as overheating or a power supply, processor, memory, or motherboard about to fail.)
- Has the computer case been opened recently? (Someone working inside the case might not have used a ground bracelet and components are now failing because of ESD damage.)
- Are case vents free so that air can flow? (The case might be close to a curtain covering the vents.)

Intermittent problems like the one Sharon described are often heat related. If the system only hangs but does not power off, the problem might be caused by faulty memory or bad software, but because it actually powers down, you can assume the problem is related to power or heat.

If Sharon tells you that the system powers down after she's been working for several hours, you can probably assume overheating. Check that first. If that's not the problem, the next thing to do is replace the power supply.

Caution Never replace a damaged motherboard with a good one without first testing or replacing the power supply. You don't want to subject another good board to possible damage.

PROBLEMS WITH OVERHEATING

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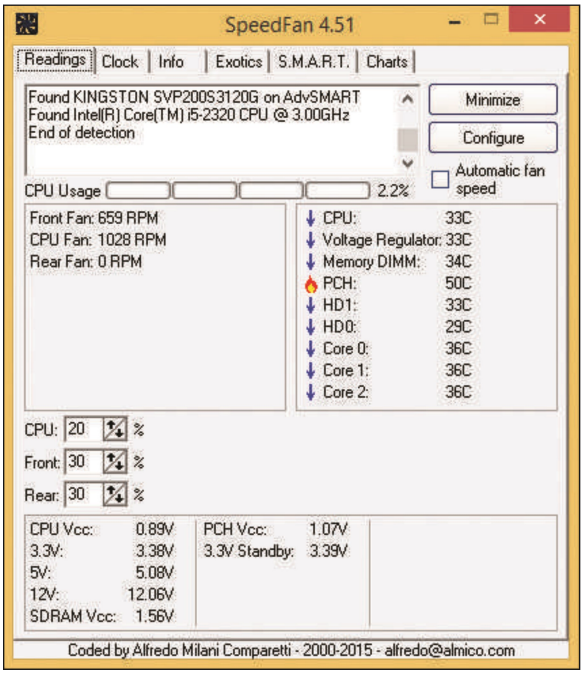
As a repair technician, you're sure to eventually face problems with computers overheating. Overheating can happen as soon as you turn on the computer or after the computer has been working a while. Overheating can cause intermittent errors, the system to hang, or components to fail or not last as long as they normally would. (Overheating can significantly shorten the life span of the CPU and memory.) Overheating happens for many reasons, including improper installation of the CPU cooler or fans, overclocking, poor airflow inside the case, an underrated power supply, a component going bad, or the computer's environment (for example, heat or dust).

Here are some symptoms that a system is overheating:

- The system hangs or freezes at odd times or freezes just a few moments after the boot starts.
- A Windows BSOD error occurs during the boot.
- You cannot hear a fan running or the fan makes a whining sound.
- You cannot feel air being pulled into or out of the case.



Source: SpeedFan by Alfredo Milani Comparetti

Figure 5-19 SpeedFan monitors fan speeds and system temperatures

If you suspect overheating, go into UEFI/BIOS screens and view the temperature monitors for the system. To protect the expensive processor and other components, you can also purchase a temperature sensor. The sensor plugs into a power connection coming from the power supply and mounts on the side of the case or in a drive bay. The sensor sounds an alarm when the inside of the case becomes too hot. To decide which temperature sensor to buy, use one recommended by the case manufacturer. You can also install utility software that can monitor system temperatures. For example, SpeedFan by Alfredo Comparetti is freeware that can monitor fan speeds and temperatures (see Figure 5-19). A good website to download the freeware is *www.filehippo.com/download_speedfan*. Be careful to not download other freeware available on the site.

Here are some simple things you can do to solve an overheating problem:

1. If the system refuses to boot or hangs after a period of activity, suspect overheating. Immediately after the system hangs, go into UEFI/BIOS setup and find the screen that reports the CPU temperature. The temperature should not exceed that recommended by the CPU manufacturer.
2. Excessive dust insulates components and causes them to overheat. Use compressed air, a blower, or an antistatic vacuum to remove dust from the power supply, the vents over the entire computer, and the processor cooler fan (see Figure 5-20). To protect the fan, don't allow it to spin as you blow air into it. Overspinning might damage a fan.

Figure 5-20 Dust in this cooler fan can cause the fan to fail and the processor to overheat

Notes When working in a customer's office or home, be sure you clean up any mess you create from blowing dust out of a computer case.

3. Check airflow inside the case. Are all fans running? You might need to replace a fan. Is there an empty fan slot on the rear of the case? If so, install a case fan in the slot (see Figure 5-21). Orient the fan so that it blows air out of the case. The power cord to the fan can connect to a fan header on the motherboard or to a power connector coming directly from the power supply.

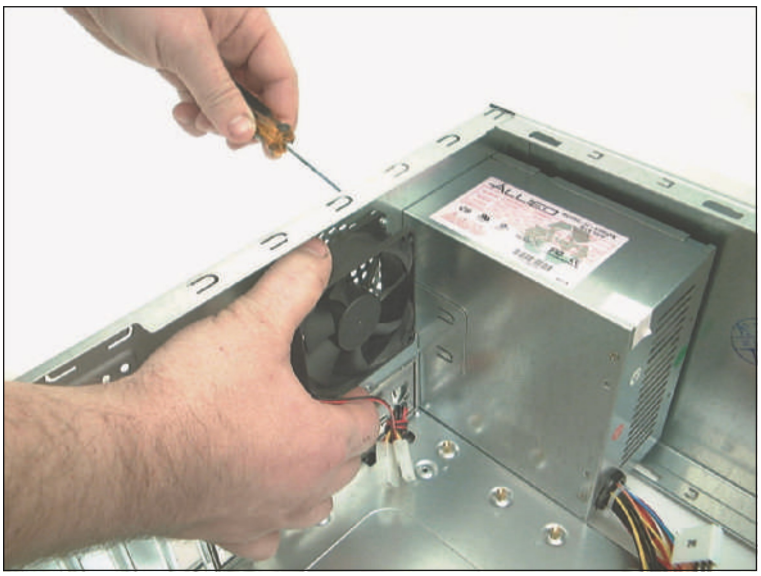


Figure 5-21 Install one exhaust fan on the rear of the case to help pull air through the case

4. If there are other fan slots on the side or front of the case, you can also install fans in these slots. However, don't install more fans than the case is designed to use.
5. Can the side of the case hold a chassis air guide that guides outside air to the processor? If it has a slot for the guide and the guide is missing, install one. However, don't install a guide that obstructs the CPU cooler. How to install an air guide is covered later in this section.

6. A case is generally designed for optimal airflow when slot openings on the front and rear of the case are covered and when the case cover is securely in place. To improve airflow, replace missing faceplates over empty drive bays and replace missing slot covers over empty expansion slots. See Figure 5-22.
7. Are cables in the way of airflow? Use tie wraps to secure cables and cords so that they don't block airflow across the processor or get in the way of fans turning. Figure 5-23 shows the inside of a case where cables are tied up and neatly out of the way of airflow from the front to the rear of the case.

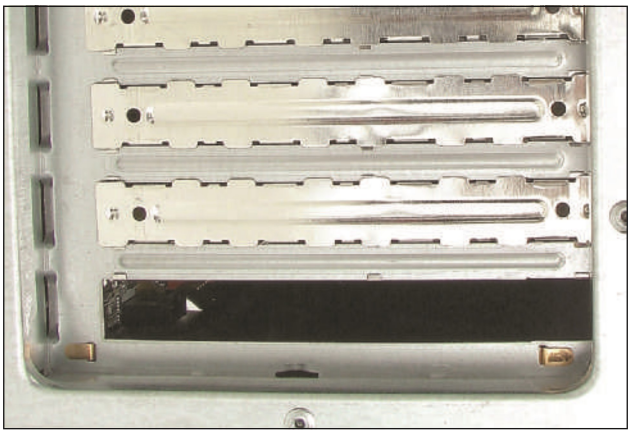


Figure 5-22 For optimum airflow, don't leave empty expansion slots and bays uncovered

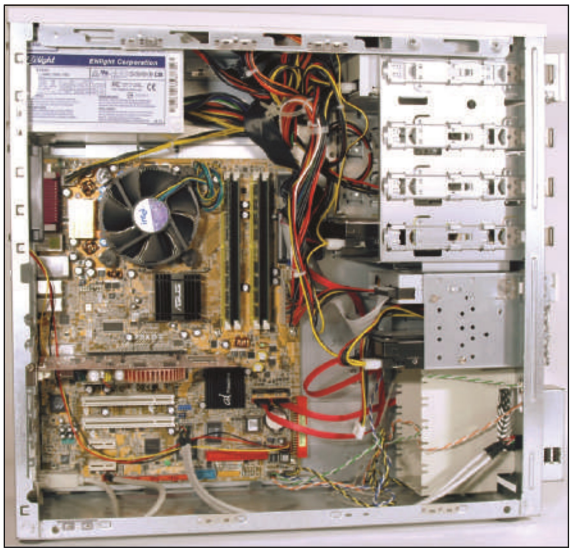


Figure 5-23 Use cable ties to hold cables out of the way of fans and airflow

8. A case needs some room to breathe. Place it so there are at least a few inches of space on both sides and the top of the case. If the case is sitting on carpet, put it on a computer stand so that air can circulate under the case and also to reduce carpet dust inside the case. Many cases have a vent on the bottom front of the case and carpet can obstruct airflow into this vent (see Figure 5-24). Make sure drapes are not hanging too close to fan openings.

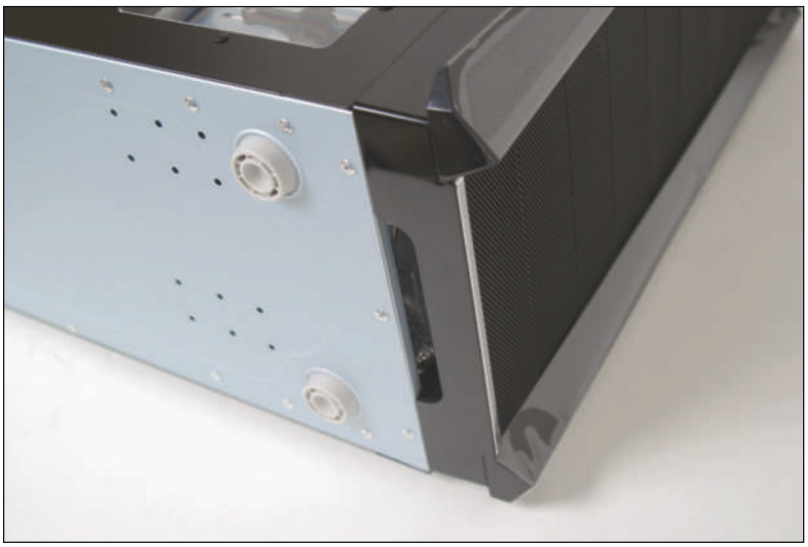


Figure 5-24 Keep a tower case off carpet to allow air to flow into the bottom air vent

9. Verify the cooler is connected properly to the processor. If it doesn't fit well, the system might not boot and certainly the processor will overheat. If the cooler is not tightly connected to the motherboard and processor or the cooler fan is not working, the processor will quickly overheat as soon as the computer is turned on. Has thermal compound been installed between the cooler and processor?
10. After you close the case, leave your system off for at least 30 minutes. When you power up the computer again, let it run for 10 minutes, go into UEFI/BIOS setup, check the temperature readings, and reboot. Next, let your system run until it shuts down. Power it up again and check the temperature in UEFI/BIOS setup again. A significant difference in this reading and the first one you took after running the computer for 10 minutes indicates an overheating problem.
11. Check UEFI/BIOS setup to see if the processor is being overclocked. Overclocking can cause a system to overheat. Try restoring the processor and system bus frequencies to default values.
12. Have too many peripherals been installed inside the case? Is the case too small for all these peripherals? Larger tower cases are better designed for good airflow than smaller slimline cases. Also, when installing cards, try to leave an empty slot between each card for better airflow. The same goes for drives. Try not to install a group of drives in adjacent drive bays. For better airflow, leave empty bays between drives. Take a close look at Figure 5-23, where you can see space between each drive installed in the system.
13. Flash UEFI/BIOS to update the firmware on the motherboard. How to flash UEFI/BIOS is covered in the chapter, "All About Motherboards."
14. Thermal compound should last for years, but eventually it will harden and need replacing. If the system is several years old, replace the thermal compound.

A+ Exam Tip The A+ 220-902 exam expects you to recognize that a given symptom is possibly power or heat related.

If you try the preceding list of things to do and still have an overheating problem, it's time to move on to more drastic solutions. Consider whether the case design allows for good airflow; the problem might be caused by poor air circulation inside the case. The power supply fan in ATX cases blows air out of the case, pulling outside air from the vents in the front of the case across the processor to help keep it cool. Another exhaust fan is usually installed on the back of the case to help the power supply fan pull air through the case. In addition, most processors require a cooler with a fan installed on top of the processor. Figure 5-25 shows a good arrangement of vents and fans for proper airflow and a poor arrangement.

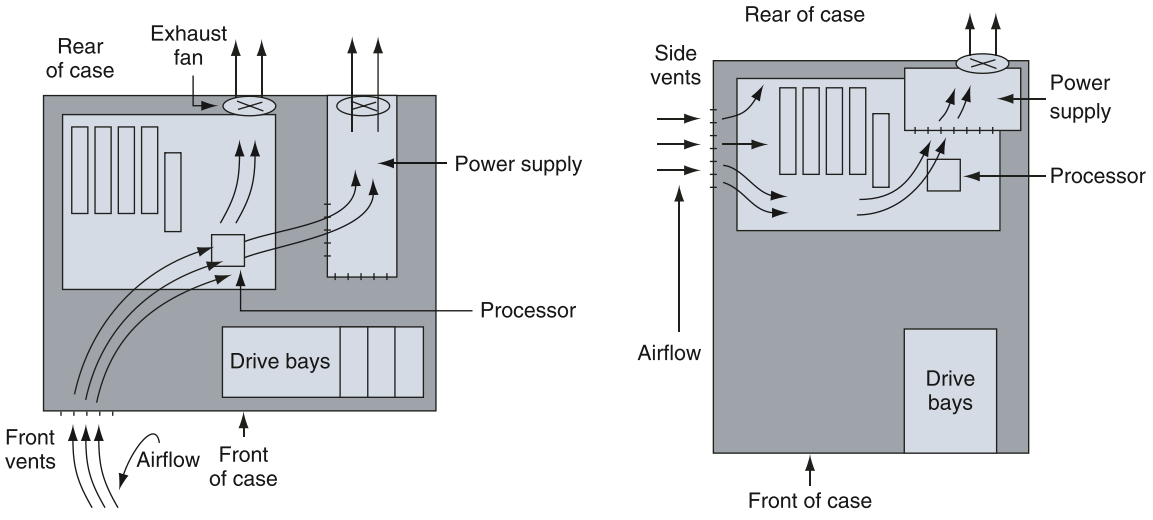


Figure 5-25 Vents and fans need to be arranged for best airflow

For better ventilation, use a power supply that has vents on the bottom and front of the power supply, as shown in Figure 5-26. Compare that with the power supply in Figure 5-21 that has vents only on the front and not on the bottom.

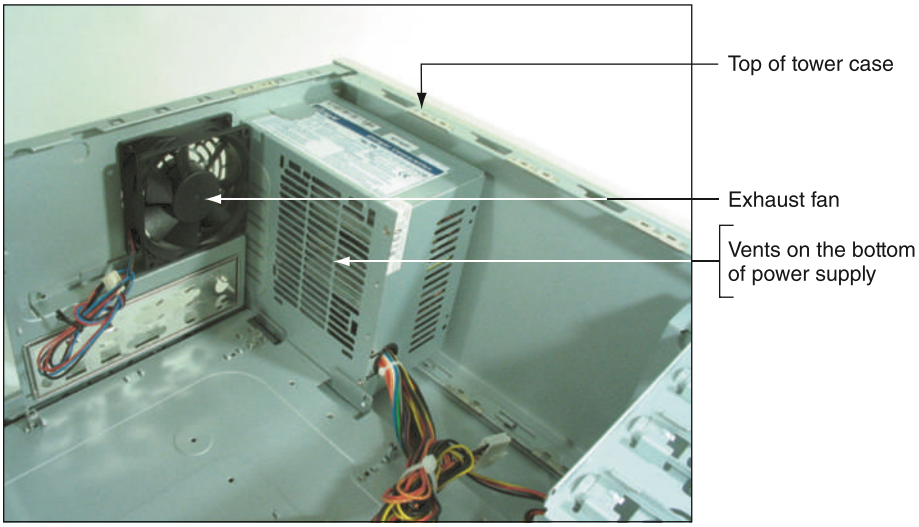


Figure 5-26 This power supply has vents on the bottom to provide better airflow inside the case

An intake fan on the front of the case might help pull air into the case. Intel recommends you use a front intake fan for high-end systems, but AMD says a front fan for ATX systems is not necessary. Check with the processor and case manufacturers for specific instructions as to the placement of fans and what type of fan and heat sink to use.

Intel and AMD both recommend a **chassis air guide (CAG)** as part of the case design. This air guide is a round air duct that helps to pull and direct fresh air from outside the case to the cooler and processor (see Figure 5-27). The guide should reach inside the case very close to the cooler, but not touch it. Intel recommends the clearance be no greater than 20mm and no less than 12mm. If the guide obstructs the cooler, you can remove the guide, but optimum airflow will not be achieved.

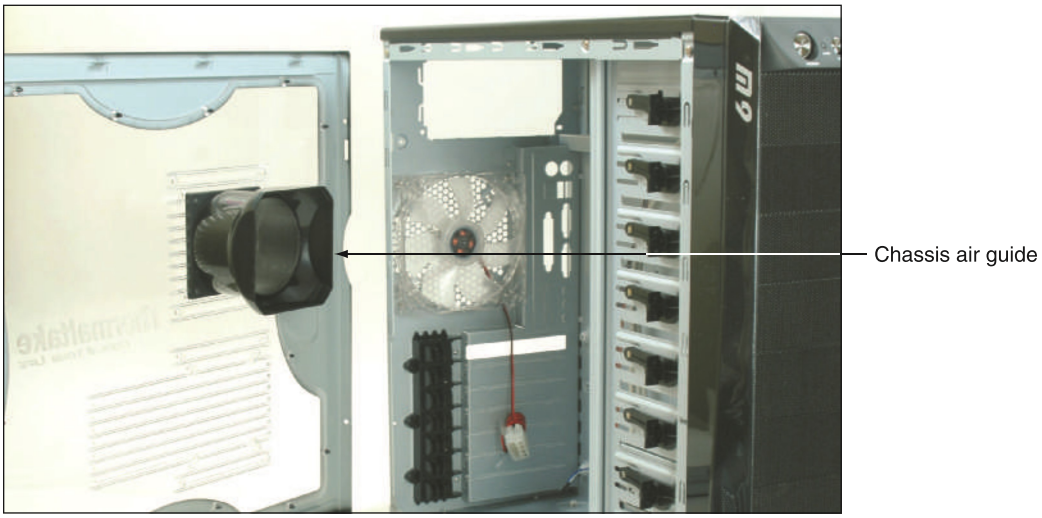


Figure 5-27 Use a chassis air guide to direct outside air over the cooler

Be careful when trying to solve an overheating problem. Excessive heat can damage the CPU and the motherboard. Never operate a system if the case fan, power-supply fan, or cooler fan is not working.

Hands-On Project 5-4 Identify Airflow Through a Case

A+ 220-901 4.1

Turn on a computer and feel the front and side vents to decide where air is flowing into and out of the case. Identify where you believe fans are working to produce the airflow. Power down the computer, unplug it, and press the power button to completely drain the power. Then open the computer case. Are fans located where you expected? Which fans were producing the strongest airflow through the case when the system was running? In which direction is each case fan drawing air, into the case or out of the case?

Hands-On Project 5-5 Blow Dust Out of a Case

A+ 220-901 4.1

If necessary, open the case cover to your desktop computer. Using a can of compressed air, blow the dust away from all fans and other components inside the case. Be careful to not touch components unless you are properly grounded. When you're done, close the case cover.

PROBLEMS WITH LAPTOP POWER SYSTEMS

A+ 220-901 4.1

A laptop can be powered by an AC adapter (which uses regular house current to power the laptop) or an installed battery pack. Battery packs today use lithium ion technology. Most AC adapters today are capable of auto-switching from 110 V to 220 V AC power. Figure 5-28 shows an AC adapter that has a green light that indicates the adapter is receiving power.

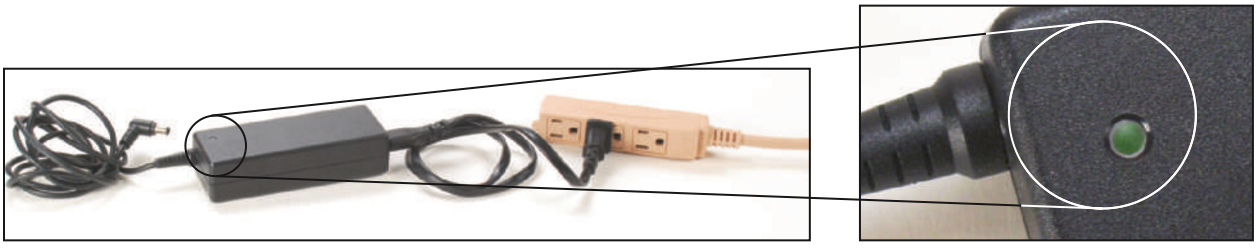


Figure 5-28 This AC adapter for a laptop uses a green light to indicate power

Some mobile users like to keep an extra battery on hand in case the first one uses up its charge. When the laptop signals that power is low, shut down the system, remove the old battery, and replace it with a charged one. To remove a battery, generally, you release a latch and then remove the battery, as shown in Figure 5-29.

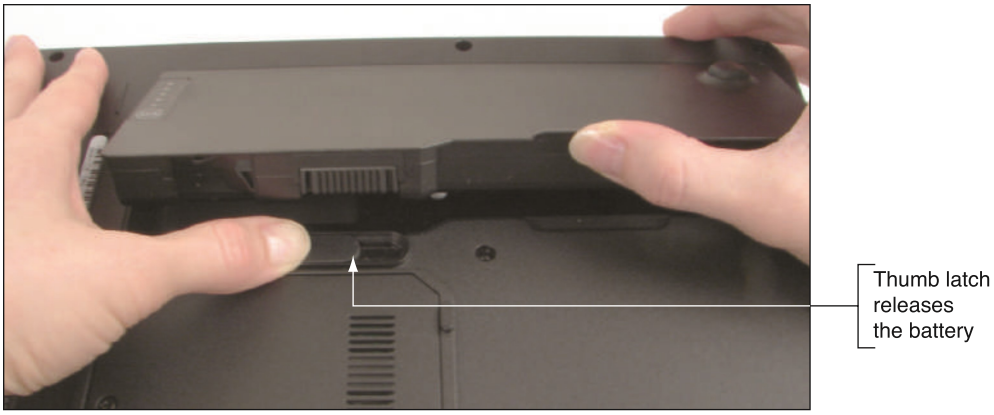


Figure 5-29 Release a latch to remove the battery from a laptop

For best battery charge times, some laptops can use two batteries. For example, the laptop in Figure 5-30 uses a second battery called a **sheet battery** that fits on the bottom of the laptop. The two batteries together give about 12 hours of use between charges. The sheet battery comes with an adapter so you can charge it when it's disconnected from the laptop.

Figure 5-30 The second battery for this laptop is a sheet battery that attaches to the bottom of the laptop and adds up to six hours to the battery charge

Notes If you're using the AC adapter to power your laptop when the power goes out, the installed battery serves as a built-in UPS. The battery immediately takes over as your uninterruptible power supply (UPS). Also, a laptop has an internal surge protector. However, for extra protection, you might want to use a power strip that provides surge protection.

Here are some problems you might encounter with laptop power systems and their solutions:

- If power is not getting to the system or the battery indicator light is lit when the AC adapter should be supplying power, verify the AC adapter is plugged into a live electrical outlet. Is the light on the AC adapter lit? Check if the AC adapter's plug is secure in the electrical outlet. Check the connections on both sides of the AC adapter transformer. Check the connection at the DC jack on the laptop. Try exchanging the AC adapter for one you know is good. The DC jack might need replacing. Most laptops allow you to replace the DC jack without replacing the entire system board. Check the service manual for the laptop to see how labor-intensive is the repair before you decide to proceed.
- If the battery is not charging when the AC adapter is plugged in, the problem might be with the battery or the motherboard. A hot battery might not charge until it cools down. If the battery is hot, remove it

from the computer and allow it to cool to room temperature. Check the battery for physical damage. If the battery is swollen or warped, replace it. If it shows no physical signs of damage, try to recharge it. If it does not recharge, replace the battery pack. If a known-good battery does not recharge, you have three options: (1) Replace the system board, (2) replace the laptop, or (3) use the laptop only when it's connected to power using the AC adapter.

APPLYING | CONCEPTS TEST AN AC ADAPTER

A+ 220-901 4.1

If the system fails only when the AC adapter is connected, it might be defective. Try a new AC adapter, or, if you have a multimeter, use it to verify the voltage output of the adapter. Do the following for an adapter with a single center pin connector:

1. Unplug the AC adapter from the computer, but leave it plugged into the electrical outlet.
2. Using a multimeter set to measure voltage in the 1 to 20 V DC range, place the red probe of the multimeter in the center of the DC connector that would normally plug into the DC outlet on the laptop. Place the black probe on the outside cylinder of the DC connector (see Figure 5-31).
3. The voltage range should be plus or minus 5 percent of the accepted voltage. For example, if a laptop is designed to use 16 V, the voltage should measure somewhere between 15.2 and 16.8 V DC.

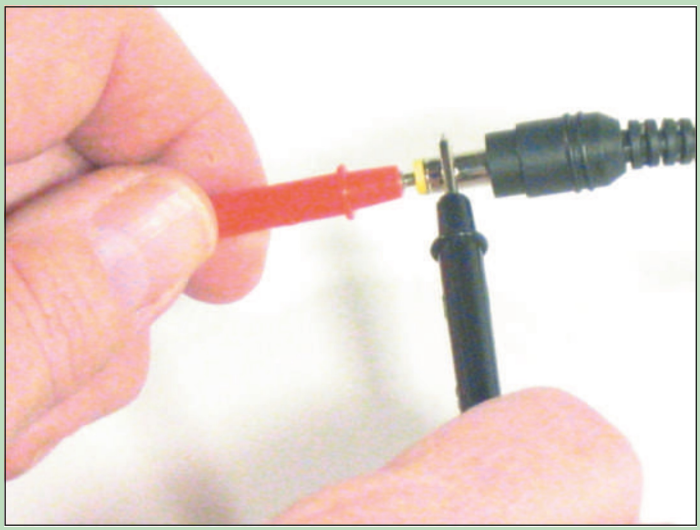


Figure 5-31 To use a multimeter to test this AC adapter, place the red probe (which, in the photo, is in the person's left hand) in the center connector and the black probe on the outside

Hands-On | Project 5-6 POST Diagnostics Cards for Laptops

A+ 220-901 4.1

Suppose you spend much of your day diagnosing problems with laptop computers. Laptops have a Mini PCI or Mini PCIe slot that works in a similar way to PCI and PCIe slots on desktop systems. Search the web for diagnostic cards that you can use in a mini PCI or mini PCIe slot that can help you diagnose hardware problems with laptops. Print the webpages showing your findings. Which diagnostic card would you choose to buy and why?

TROUBLESHOOTING THE MOTHERBOARD, PROCESSOR, AND RAM

A+ 220-901 4.1

The field replaceable units (FRUs) on a motherboard are the processor, the processor cooler assembly, RAM, and the CMOS battery. Also, the motherboard itself is an FRU. As you troubleshoot the motherboard and discover that some component is not working, such as a network port, you might be able to disable that component in UEFI/BIOS setup and install a card to take its place.

A+ Exam Tip The A+ 220-901 exam expects you to know how to troubleshoot problems with motherboards, processors, and RAM.

When you suspect a bad component, a good troubleshooting technique is to substitute a known-good component for the one you suspect is bad. Be cautious here. A friend once had a computer that wouldn't boot. He replaced the hard drive, with no change. He replaced the motherboard next. The computer booted up with no problem; he was delighted, until it failed again. Later he discovered that a faulty power supply had damaged his original motherboard. When he traded the bad one for a good one, the new motherboard also got zapped! If you suspect problems with the power supply, check the voltage coming from the power supply before putting in a new motherboard.

Symptoms that a motherboard, processor, or memory module is failing can appear as:

- The system begins to boot but then powers down.
- An error message is displayed during the boot. Investigate this message.
- The system reports less memory than you know is installed.
- The system becomes unstable, hangs, or freezes at odd times. (This symptom can have multiple causes, including a failing power supply, RAM, hard drive, motherboard or processor, Windows errors, and overheating.)
- Intermittent Windows or hard drive errors occur.
- Components on the motherboard or devices connected to it don't work.

Remember the troubleshooting principle to check the simple things first. The motherboard and processor are expensive and time consuming to replace. Unless you're certain the problem is one of these two components, don't replace either until you first eliminate other components as the source of the problem.

If you can boot the system, follow these steps to eliminate Windows, software, RAM, BIOS settings, and other software and hardware components as the source of the problem:

1. If an error message appears, Google the error message. Pay particular attention to hits on the motherboard or processor manufacturer or Microsoft websites. Search forums for information about the error.
2. The problem might be a virus. If you can boot the system, run a current version of antivirus software to check for viruses.
3. A memory module might be failing. In Windows 8/7/Vista, use the Memory Diagnostics tool to test memory. Even if Windows is not installed, you can still run the tool by booting the system from the Windows setup DVD. How to use the Memory Diagnostics tool is coming up later in this chapter.

Notes Other than the Windows Memory Diagnostics tool, you can use the Memtest86 utility to test installed memory modules. Check the site *www.memtest86.com* to download this program.

4. Suspect the problem is caused by an application or by Windows. In Windows, the best tool to check for potential hardware problems is Device Manager.
5. In Windows, download and install any Windows updates or patches. These updates might solve a hardware or application problem.

Notes Another useful Windows tool for troubleshooting hardware problems is Event Viewer, which reports logs of hardware and application errors. A Real Problems, Real Solutions activity at the end of this chapter gives you experience using Event Viewer.

6. Ask yourself what has changed since the problem began. If the problem began immediately after installing a new device or application, uninstall the device or applications.
7. A system that does not have enough RAM can sometimes appear to be unstable. Using the System window, find out how much RAM is installed, and compare that with the recommended amounts. Consider upgrading RAM.
8. The UEFI/BIOS might be corrupted or have wrong settings. Check UEFI/BIOS setup. Have settings been tampered with? Is the CPU speed set incorrectly or is it overclocked? Reset UEFI/BIOS setup to restore default settings.
9. Disable any quick booting features in UEFI/BIOS so that you get a thorough report of POST. Then look for errors reported on the screen during the boot.
10. Flash BIOS to update the firmware on the board.
11. Check the motherboard manufacturer's website for diagnostic software that might identify a problem with the motherboard.
12. Update all drivers of motherboard components that are not working. For example, if the USB ports are not working, try updating the USB drivers with those downloaded from the motherboard manufacturer's website. This process can also update the chipset drivers.
13. If an onboard port or device isn't working, but the motherboard is stable, follow these steps:
    a. Verify the problem is not with the device using the port. Try moving the device to another port on the same computer or move the device to another computer. If it works there, return it to this port. The problem might have been a bad connection.
    b. Go into UEFI/BIOS setup and verify the port is enabled.
    c. Check Device Manager and verify Windows recognizes the device or port with no errors. For example, Device Manager shown in Figure 5-32 reports the onboard Wi-Fi adapter is disabled. Try to enable the device.

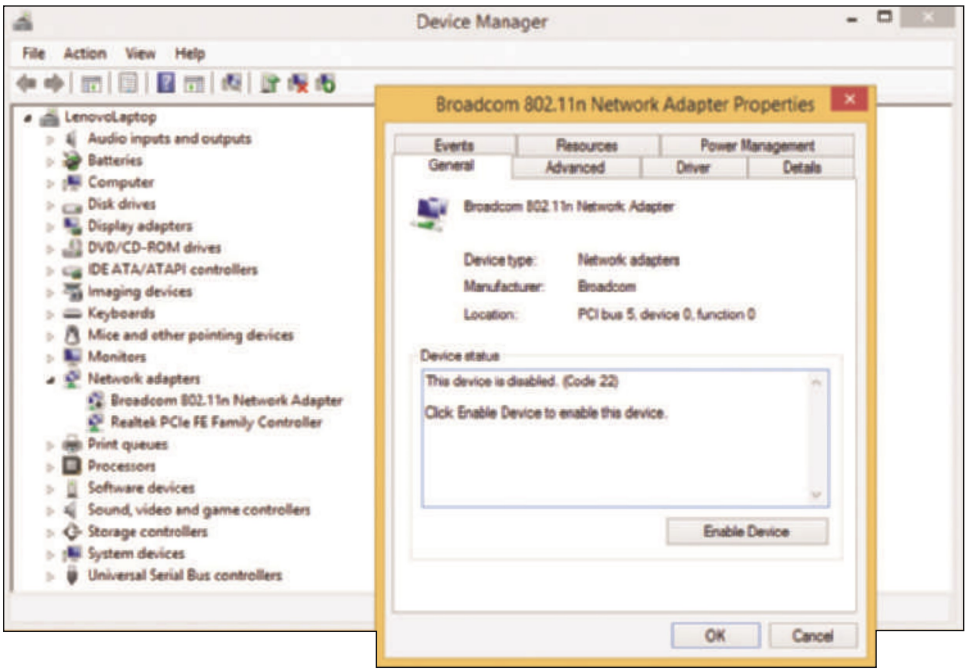


Figure 5-32 Device Manager reports a problem with an onboard port

d. Next try updating the motherboard drivers for this device from the motherboard manufacturer's website.
e. If you have a loopback plug, use it to test the port.
f. If the problem is still not solved, disable the port in BIOS setup and install an expansion card to provide the same type of port or connector.

14. Suspect the problem is caused by a failing hard drive. How to troubleshoot a failing drive is covered in the chapter, "Supporting Hard Drives and Other Storage Devices."
15. Suspect the problem is caused by overheating. How to check for overheating is covered earlier in this chapter.
16. Verify the installed processor is supported by the motherboard. Perhaps someone has installed the wrong processor.

APPLYING CONCEPTS USE WINDOWS MEMORY DIAGNOSTICS

A+ 220-901 4.1

Errors with memory are often difficult to diagnose because they can appear intermittently and might be mistaken as application errors, user errors, or other hardware component errors. Sometimes these errors cause the system to hang, a blue screen error might occur, or the system continues to function with applications giving errors or data getting corrupted. You can quickly identify a problem with memory or eliminate memory as the source of a problem by using the Windows 8/7/Vista Memory Diagnostics tool. Use one of these two methods to start the utility:

- ***Use the mdsched.exe command from within Windows***. To open a command prompt window from the Windows 8 desktop, right-click **Start** and click **Command Prompt**. (In Windows 7, click **Start**, enter **command** or **cmd**, and press **Enter**.) In the command prompt window, enter **mdsched.exe** and press **Enter**. A dialog box appears (see Figure 5-33) asking if you want to run the test now or on the next restart.

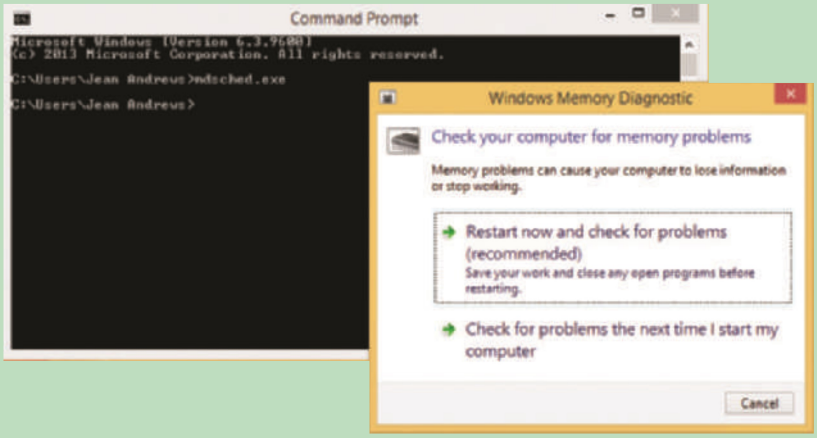


Figure 5-33 Use the mdsched.exe command to test memory

- ***Boot from the Windows setup DVD***. If Windows is not the installed operating system or you cannot boot from the hard drive, boot the computer from the Windows setup DVD. On the opening screen, select your language. On the next screen (see Figure 5-34), click **Repair your computer**. For Windows 8, in the following boxes, click **Troubleshoot** and then **Advanced options**. On the Advanced options screen, click **Command Prompt**. At the command prompt, enter **mdsched.exe** and press **Enter**. For Windows 7, select the Windows installation to repair. On the System Recovery Options screen (see Figure 5-35), click **Windows Memory Diagnostic**.

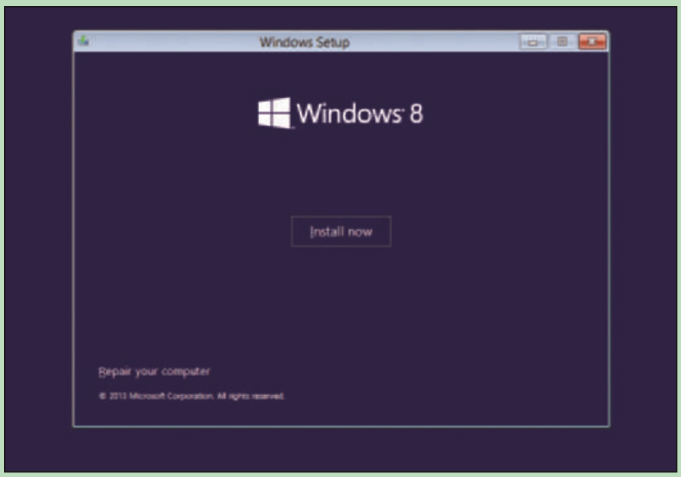


Figure 5-34 Opening menu when you boot from the Windows 8 setup DVD

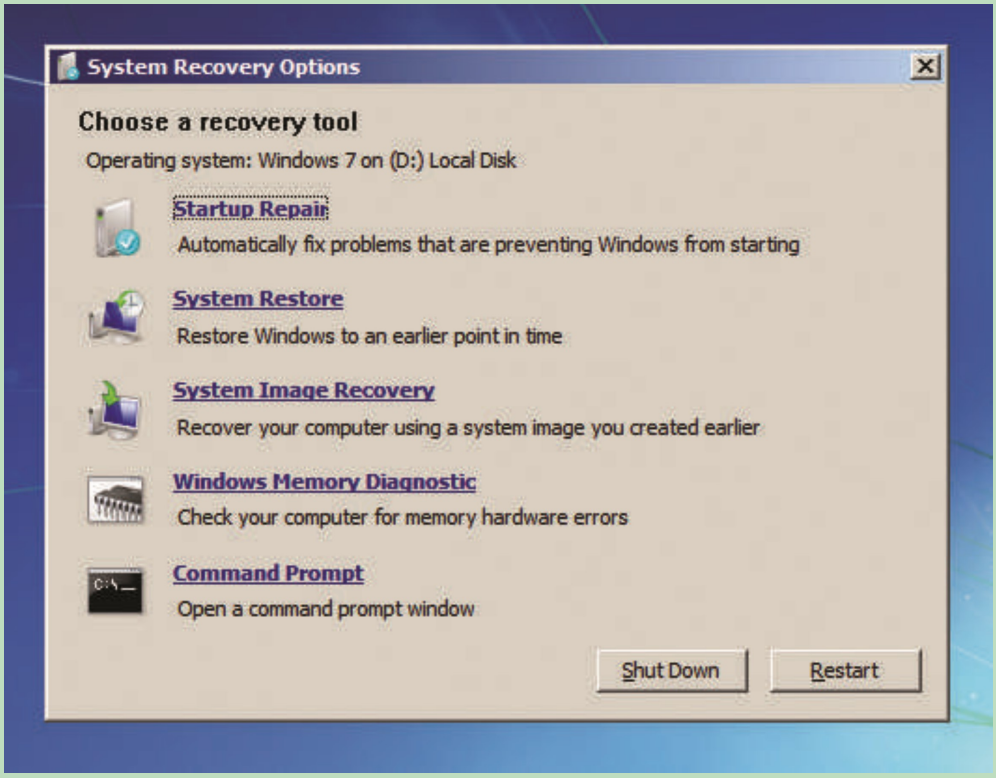


Figure 5-35 Test memory using the Windows 7 System Recovery Options menu

If the tool reports memory errors, replace all memory modules installed on the motherboard.

APPLYING | CONCEPTS USE DEVICE MANAGER TO DELETE THE DRIVER STORE

A+ 220-901 4.1

One thing you can do to solve a problem with a device is to uninstall and reinstall the device. When you first install a device, Windows stores a copy of the driver package in a **driver store**. When you uninstall the device, you can tell Windows to also delete the driver store. If you don't delete the driver store, Windows uses it when you install the device again. That's why the second time you install the same device Windows does not ask you for the location of the drivers. Windows might also use the driver store to automatically install the device on the next reboot without your involvement.

All this is convenient unless there is a problem with the driver store. To get a true fresh start with an installation, you need to delete the driver store. To do that, first sign in to Windows using an account with administrative privileges and then follow these steps:

1. To open Device Manager from the Windows 8 desktop, right-click **Start** and click **Device Manager**. (In Windows 7, click **Start** and click **Control Panel**. In Control Panel Classic icon view, click **Device Manager**.) Device Manager opens.

A+ Exam Tip The A+ 220-902 exam expects you to be familiar with Control Panel in Classic icon view. If Control Panel is showing Category view, click **Category**, and then click **Large icons** or **Small icons**.

2. Right-click the device and click **Properties** in the shortcut menu. Click the **Driver** tab and click **Uninstall**. In the Confirm Device Uninstall box, check **Delete the driver software for this device**, and click **OK**. See Figure 5-36. The installed drivers and the driver store are both deleted. When you reinstall the device, you'll need the drivers on CD or downloaded from the web.

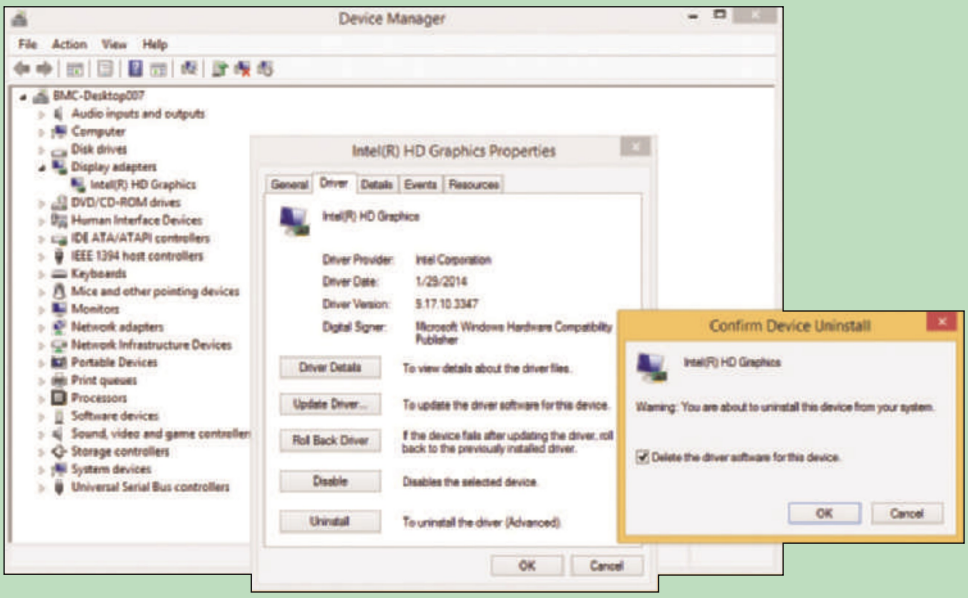


Figure 5-36 Use Device Manager to uninstall the drivers and delete the driver store for a device

Also know if the check box is missing on the Confirm Device Uninstall box, the drivers are embedded in Windows and you cannot delete the driver store for these devices. Examples of these devices are the optical drive, hard drive, and generic keyboard, which all have embedded Windows drivers.

We're working our way through what to do when the system locks up, gives errors, or generally appears unstable. Another problem that can occur at the boot is continuous reboots, which can be caused by overheating, a failing processor, motherboard, or RAM, or a corrupted Windows installation. For Windows 8, many continuous restart errors can be solved by performing a Startup Repair process. Follow these steps:

1. Boot from the Windows 8 setup DVD. (You might need to first change the boot priority order in UEFI/BIOS setup to boot first from the optical drive.)
2. On the opening screen, select your language. On the next screen (refer back to Figure 5-34), click **Repair your computer**. Next click **Troubleshoot** and then **Advanced options**. On the Advanced options screen (see Figure 5-37), click **Startup Repair** and follow directions on screen.

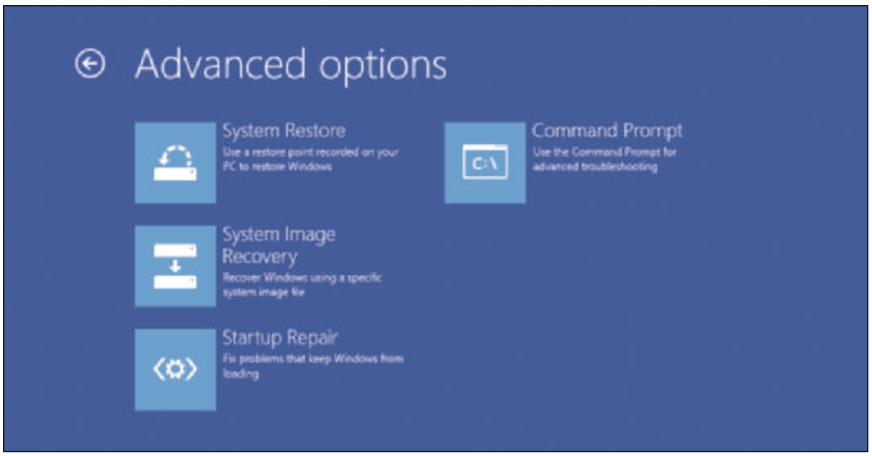


Figure 5-37 Startup Repair on the Advanced options menu can solve problems launching Windows 8

For Windows 7/Vista, error messages disappear before they can be read as the system reboots. To disable these automatic restarts, press F8 as Windows starts up. The Advanced Boot Options menu appears (see Figure 5-38). Select Disable automatic restart on system failure. When you restart Windows,

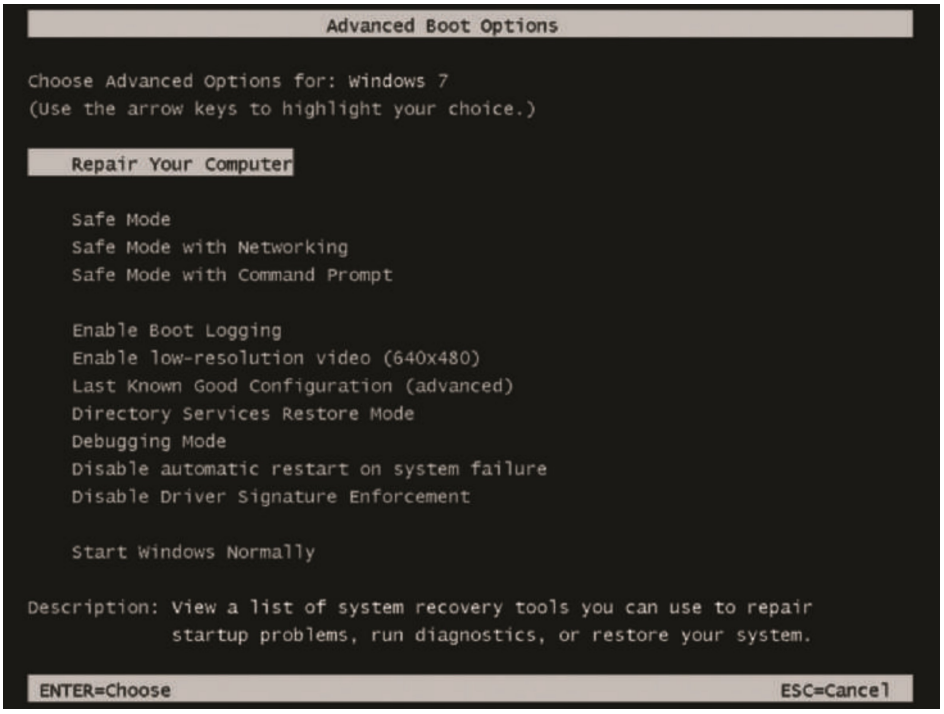


Figure 5-38 Press F8 during the boot to see the Windows 7 Advanced Boot Options menu

the error message stays on screen long enough for you to read it. Search the Microsoft websites (*support.microsoft.com* and *technet.microsoft.com*) for information about the hardware component causing the problem and what to do about it. BSOD errors might apply to the motherboard, video card, RAM, processor, hard drive, or some other device for which Windows is trying to load device drivers.

If you have checked Windows and UEFI/BIOS settings and searched the web for help and still have not identified the source of the problem, it's time to open the case and check inside. As you do so, be sure to use an ESD strap and follow other procedures to protect the system against ESD. With the case open, follow these steps:

1. Check that all the power and data cables the system is using are securely connected. Try reseating all expansion cards and DIMM modules.
2. Look for physical damage on the motherboard. Look for frayed traces on the bottom of the board or discolored, distended, or bulging capacitors on the board.
3. Reduce the system to essentials. Remove any unnecessary hardware, such as expansion cards, and then watch to see if the problem goes away. If the problem goes away, replace one component at a time until the problem returns and you have identified the component causing the trouble.
4. Try using a POST diagnostic card. It might offer you a clue as to which component is giving a problem.
5. Suspect the problem is caused by a failing power supply. It's less expensive and easier to replace than the motherboard or processor, so eliminate it as a cause before you move on to the motherboard or processor.
6. Exchange the processor.
7. Exchange the motherboard, but before you do, measure the voltage output of the power supply or simply replace it, in case it is producing too much power and has damaged the board.

APPLYING | CONCEPTS DISCOLORED CAPACITORS

A+ 220-901 4.1

Jessica complained to Wally, her IT support technician, that Windows was occasionally giving errors, data would get corrupted, or an application would not work as it should. At first, Wally suspected Jessica might need a little more training on how to open and close an application or save a file, but he discovered user error was not the problem. He tried reinstalling the application software Jessica most often used, and even reinstalled Windows, but the problems persisted.

Notes Catastrophic errors (errors that cause the system to not boot or a device to not work) are much easier to resolve than intermittent errors (errors that come and go).

Wally began to suspect a hardware problem. Carefully examining the motherboard revealed the source of the problem: failing capacitors. Look carefully at Figure 5-39 and you can see five bad **discolored capacitors** with bulging heads. (Know that sometimes a leaking capacitor can also show crusty corrosion at the base of the capacitor.) When Wally replaced the motherboard, the problems went away.

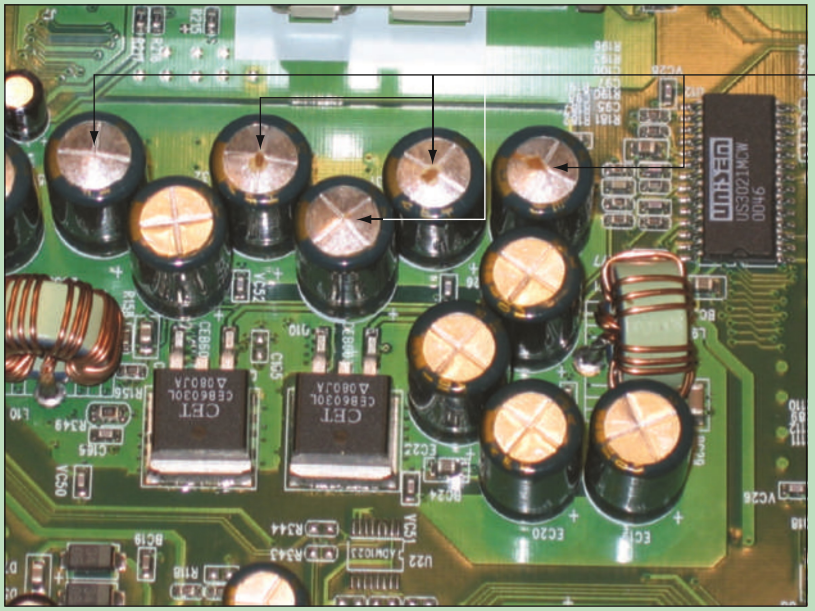


Figure 5-39 These five bad capacitors have bulging and discolored heads

Hands-On Project 5-7 Troubleshoot Memory

A+ 220-901 4.1

Do the following to troubleshoot memory:

1. Open the Windows System window and record the amount of memory in your system.
2. Follow the rules to protect a computer against ESD as you work. Remove the memory module in the first memory slot on the motherboard, and boot the computer. Did you get an error? Why or why not? Replace the module and verify the system starts with no errors and that the full amount of memory is recognized by Windows.
3. Use the Windows 8/7/Vista Memory Diagnostics tool to test memory. About how long did the test take? Were any errors reported?

Hands-On Project 5-8 Sabotage and Repair a Computer

A+ 220-901 4.1

Open the computer case and create a hardware problem with your computer that prevents the system from booting without damaging a component. For example, you can disconnect a data cable or power cable or loosen a DIMM in a memory slot. Close the computer case and restart the system. Describe the problem as a user would describe it who does not know much about computer hardware. Power down the system and fix the problem. Boot up the system and verify all is well.

TROUBLESHOOTING MOBILE DEVICES

A+ 220-901 4.5

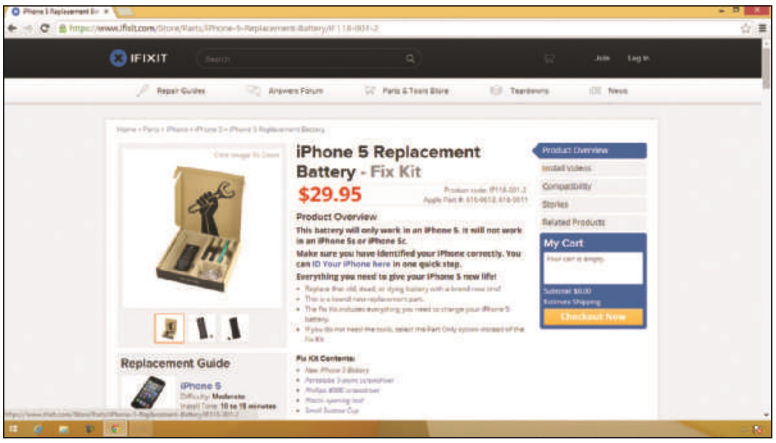
Here is what to do for problems with a cell phone that is overheating:

- Check if the heat is coming from the bottom of the cell phone where the battery is located. If so, try these things:
  - Use a different AC adapter to charge the battery.
  - If the phone is not under warranty, open the case and examine the battery for damage. Is it swollen or warped? If so, replace the battery. If the phone is under warranty, lay the phone on a flat surface. If the phone appears warped, take it in for repair.

Notes Some Android cell phones will provide information about the device when you enter ***#*#4636#*#*** in the phone keypad. In the screen that appears, select Battery Information. If the Battery Health screen reports "unknown," suspect a bad battery. The temperature of the battery is also reported on this screen, which should be less than 40°C.

- If heat is coming from other areas of the phone, try these things:
  - Too many apps might be open. Close all apps you're not currently using.
  - Follow troubleshooting steps for your phone's operating system to resolve the problem. These steps include updating the OS. For more information, see the chapter, "Supporting Mobile Operating Systems."
  - The phone processor might be overworked by streaming data (watching a movie online), playing a game, or texting. Allow the phone to rest and cool down.
  - Consider removing the phone from a case that doesn't allow heat to dissipate.

If you decide the battery is the problem, check if the phone is under warranty. If not, you are likely to find teardown directions to replace the battery online. For example, at *ifixit.com* the kit to replace the iPhone 5 battery includes the battery, tools, and directions (see Figure 5-40). You can also watch videos on the site to step you through the process.



Source: IFIXIT

Figure 5-40 At *www.ifixit.com*, you can purchase tools, parts, and instructions to replace an iPhone battery

Here are some other problems and solutions for cell phones and phablets:

- For a frozen system, do the following:
  - For the iPhone or iPad, reset the device. To do so, hold down the Wake/sleep button and the Home button at the same time for at least 10 seconds until the Apple logo appears.

- For a frozen Android device, you can reboot the system by following manufacturer directions for a reboot for the specific device. As a last resort, you can open the back of the device and remove and reinstall the battery.
- For Windows Phone, first try holding down the Power button and then swipe Slide down to power off. Power back up your phone. If that doesn't work, press and hold the Volume Down and Power buttons at the same time for at least 10 seconds until you feel a vibration. If that doesn't work, open the back of the device and remove and reinstall the battery.

- When the battery charge lasts an extremely short time, first try exchanging the AC adapter (charger). If that doesn't work, exchange the battery unless the device is under warranty.
- When installing apps that don't load or load slowly, a hot or failing battery might be the problem. Other problems might be a failing network connection. Reset the Wi-Fi or Bluetooth connection. If your device is connected to your computer with a USB connection, check the USB connection.
- For slow performance, close apps you're not using, clean Android cached data, and disable live wallpapers. Consider performing a factory reset and start over by installing only the apps you actually use. For more information, see the chapter, "Supporting Mobile Operating Systems."
- Email encryption is done using a public key and private key. You distribute your public key to those who want to send you encrypted email and you keep the private key on your device. If your device is unable to decrypt email, most likely you'll need to generate a new public key and private key and distribute your new public key to those who send you encrypted email.

APPLYING | CONCEPTS LESSONS LEARNED

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Sophia is putting together a computer from parts for the first time. She has decided to keep costs low and is installing an AMD processor on a microATX motherboard, using all low-cost parts. She installed the hard drive, optical drive, and power supply in the computer case. Then she installed the motherboard in the case, followed by the processor, cooler, and memory. Before powering up the system, she checked all connections to make sure they were solid and read through the motherboard documentation to make sure she did not forget anything important. Next, she plugs in the monitor to the onboard video port and then plugs in the keyboard and power cord. She takes a deep breath and turns on the power switch on the back of the computer. Immediately, she hears a faint whine, but she's not sure what is making the noise. When she presses the power button on the front of the case, nothing happens. No fans, no lights. Here are the steps Sophia takes to troubleshoot the problem:

1. She turns off the power switch and unplugs the power cord. She remembers to put on her ground bracelet and carefully checks all power connections. Everything looks okay.
2. She plugs in the system and presses the power button again. Still all she hears is the faint whine.
3. She presses the power button a second and third time. Suddenly a loud pop followed by smoke comes from the power supply, and the strong smell of electronics fills the room! Sophia jumps back in dismay.
4. She removes a known-good power supply from another computer, disconnects the blown power supply, and connects the good one to the computer. When she turns on the power switch, she hears that same faint whine. Quickly she turns off the switch and unplugs the power cord. She does not want to lose another power supply!
5. Next, Sophia calls technical support of the company that sold her the computer parts. A very helpful technician listens carefully to the details and tells Sophia that the problem sounds like a short in the system. He explains that a power supply might whine if too much power is being drawn. As Sophia hangs up the phone, she begins to think that the problem might be with the motherboard installation.

(continues)

6. She removes the motherboard from the case, and the source of the problem is evident: She forgot to install spacers between the board and the case. The board was sitting directly on the bottom of the case, which had caused the short.
7. Sophia installs the spacers and reinstalls the motherboard. Using the good power supply, she turns on the system. The whine is gone, but the system is dead.
8. Sophia purchases a new power supply and motherboard, and this time, carefully uses spacers in every hole used by the motherboard screws. Figure 5-41 shows one installed spacer and one ready to be installed. The system comes up without a problem.

Figure 5-41 Spacers installed in case holes keep the motherboard from causing a short

In evaluating her experience with her first computer build, Sophia declares the project a success. She was grateful she had decided to use low-cost parts for her first build. She learned much from the experience and will never, ever forget to use spacers. She told a friend, "I made a serious mistake, but I learned from it. I feel confident I know how to put a system together now, and I'm ready to tackle another build. When you make mistakes and get past them, your confidence level actually grows because you learn you can face a serious problem and solve it."

>> CHAPTER SUMMARY

Cooling Methods and Devices

- Devices that are used to keep a processor and system cool include CPU coolers and fans, thermal compound, case fans, heat sinks, and liquid cooling.
- Liquid cooling systems use liquids pumped through the system to keep it cool and are sometimes used by hobbyists when overclocking a system.

Selecting a Power Supply

- Important features of a power supply to consider when purchasing it are its form factor, wattage capacity, number and type of connectors it provides, and warranty.
- To decide on the wattage capacity of a power supply, add up the wattage requirements for all components in a system and then increase that total by about 30 percent. The wattage provided by the +12 V rail is also important.

How to Approach a Hardware Problem

- If possible, always begin troubleshooting a computer problem by interviewing the user. Find out when the problem started and what happened about the time it started. You also need to know if important data on the computer is not backed up. When troubleshooting, set your priorities based on user needs.
- Sources that can help with hardware troubleshooting are the web, online technical support and forums, diagnostic software, user manuals, and your network of technical associates.
- When troubleshooting, check the simple things first. For example, you can scan for viruses, test RAM, and run diagnostic software before you begin the process of replacing expensive components.
- Decide if a computer problem occurs before or after a successful boot and if it is caused by hardware or software. After you have fixed the problem, verify the fix and document the outcome.
- When troubleshooting mobile devices, consider the warranty and that replacing a component might cost more than replacing the device. If possible, substitute an external component for an internal one.

Troubleshooting the Electrical System

- To determine if a system is getting power, listen for spinning fans or drives and look for indicator lights.
- Use a power supply tester to test the power supply.
- Intermittent problems that come and go are the most difficult to solve and can be caused by hardware or software. The power supply, motherboard, RAM, processor, hard drive, and overheating can cause intermittent problems.
- Removing dust from a system, providing for proper ventilation, and installing extra fans can help to keep a system from overheating.
- The battery and the DC jack are considered field replaceable units in a laptop that pertain to the power system.
- Use a multimeter to check the voltage output of an AC adapter.

Troubleshooting the Motherboard, Processor, and RAM

- UEFI/BIOS gives beep codes when a POST error occurs during the boot before it tests video.
- Error messages on a black screen during the boot are usually put there by startup UEFI/BIOS during POST.
- Error messages on a blue screen during or after the boot are put there by Windows and are called the blue screen of death (BSOD).
- The motherboard, processor, RAM, processor cooler assembly, and CMOS battery are field replaceable units.
- An unstable system that freezes or hangs at odd times can be caused by a faulty power supply, RAM, hard drive, motherboard, or processor, Windows error, or overheating.
- A POST diagnostic card can troubleshoot problems with the motherboard.

Troubleshooting Mobile Devices

- A mobile device battery that overheats or quickly loses its charge might need replacing, but first try replacing the AC adapter (charger).
- For a frozen system, try resetting an iPhone or iPad, rebooting an Android device, or resetting Windows Phone. You can also try removing the battery and reinstalling it.

>> KEY TERMS

For explanations of key terms, see the Glossary for this text.

AC adapter
auto-switching
blue screen of death (BSOD)
case fan
chassis air guide (CAG)
cooler
discolored capacitor
driver store
dual rail
fanless CPU cooler
file recovery software
heat sink
lithium ion
Memory Diagnostics
passive CPU cooler
processor thermal trip error
sheet battery
Windows pinwheel

>> REVIEWING THE BASICS

1. What are the two major components of a processor cooler assembly?
2. How many pins does the CPU fan header on a motherboard have?
3. If the power connector from the CPU fan has only three pins, it can still connect to the 4-pin header, but what functionality is lost?
4. How do you determine the wattage capacity needed by a power supply?
5. Which one component in a high-end gaming computer is likely to draw the most power?
6. When you first turn on a computer and you don't hear a spinning drive or fan or see indicator lights, is the problem hardware or software related?
7. What is a Windows error message called that appears on a blue screen?
8. How many beeps does startup UEFI/BIOS give to indicate a successful POST?
9. Which two components in a system might give out a loud whining noise?
10. What Windows utility can you use to test RAM?
11. Which Windows tool is best to use to verify that hardware components installed in Windows are working properly?
12. What is the purpose of standoffs installed between the bottom of the case and the motherboard?
13. If a system hangs after being used for several hours and you suspect overheating, what can you do to easily monitor the CPU and system temperature?
14. What are two reasons to tie cables up and out of the way inside a computer case?
15. Why should a tower case not sit on thick carpet?
16. For most computer cases, does air flow from front to rear or rear to front?
17. Which type of CPU cooler contains heat pipes?
18. What can you do if a port on the motherboard is faulty and a device requires this type of port?
19. What can you do to stop a computer from repeatedly restarting in a continuous loop?
20. When a cell phone overheats, why is it important to find out whether the heat is coming from the bottom of the phone or from other areas of the phone?

>> THINKING CRITICALLY

1. How much power is consumed by a load drawing 5 A with 120 V across it?
2. What is a reasonable wattage capacity for a power supply to be used with a system that contains a DVD drive, three hard drives, and a high-end video card?
   a. 250 W
   b. 1000 W
   c. 700 W
   d. 150 W
3. You upgrade a faulty PCIe video card to a recently released higher-performing card. Now the user complains that Windows 8 hangs a lot and gives errors. Which is the most likely source of the problem? Which is the least likely source?
   a. Overheating
   b. Windows does not support the new card
   c. The drivers for the card need updating
   d. Memory is faulty
4. What should you immediately do if you turn on a computer and smell smoke or a burning odor?
   a. Unplug the computer.
   b. Dial 911.
   c. Find a fire extinguisher.
   d. Press a key on the keyboard to enter BIOS setup.
5. When you boot up a computer and hear a single beep, but the screen is blank, what can you assume is the source of the problem?
   a. The video card or onboard video
   b. The monitor or monitor cable
   c. Windows startup
   d. The processor
6. You suspect that a power supply is faulty, but you use a power supply tester to measure its voltage output and find it to be acceptable. Why is it still possible that the power supply may be faulty?
7. Someone asks you for help with a computer that hangs at odd times. You turn it on and work for about 15 minutes, and then the computer freezes and powers down. What do you do first?
   a. Replace the surge protector.
   b. Replace the power supply.
   c. Wait about 30 minutes for the system to cool down and try again.
   d. Install an additional fan.

>> REAL PROBLEMS, REAL SOLUTIONS

REAL PROBLEM 5-1 Replacing a Power Supply

Suppose you turn on a system and everything is dead—no lights, nothing on the monitor screen, and no spinning fan or hard drive. You verify the power to the system works, all power connections and power cords are securely connected, and all pertinent switches are turned on. You can assume the power supply has gone bad. It's time to replace it. To prepare for this situation in a real work environment, exchange power supplies with another student in your lab who is using a computer that has a power supply rated at about the same wattage as yours. Then verify that your system starts up and works.

REAL PROBLEM 5-2 Using Event Viewer to Troubleshoot a Hardware Problem

Just about anything that happens in Windows is recorded in Event Viewer (Eventvwr.msc). You can find events such as a hardware or network failure, OS error messages, or a device that has failed to start. When you first encounter a Windows, hardware, application, or security problem, get in the habit of checking Event Viewer as one of your first steps toward investigating the problem. To save time, first check the Administrative Events log because it filters out all events except Warning and Error events, which are the most useful for troubleshooting. Do the following to practice using Event Viewer:

1. For Windows 8, press **Win+X**, click **Run**, and enter **eventvwr.msc**. For Windows 7, enter **eventvwr.msc** in the Search box. Event Viewer opens. Drill down into the **Custom Views** list in the left pane and click **Administrative Events**. Scroll through the list of Error or Warning events and list any that indicate a possible hardware problem. Make note of the first event in the list.
2. Disconnect the network cable.
3. In the Event Viewer menu bar, click **Action** and **Refresh** to refresh the list of events. How many new events do you see? Click each new event to see its details below the list of events until you find the event that tells you the network cable was unplugged. Figure 5-42 shows Event Viewer for Windows 7. Describe the details of the event about the network cable.
4. Tinker around with other hardware on your computer. What actions did you take that triggered a Warning or Error event in Event Viewer?

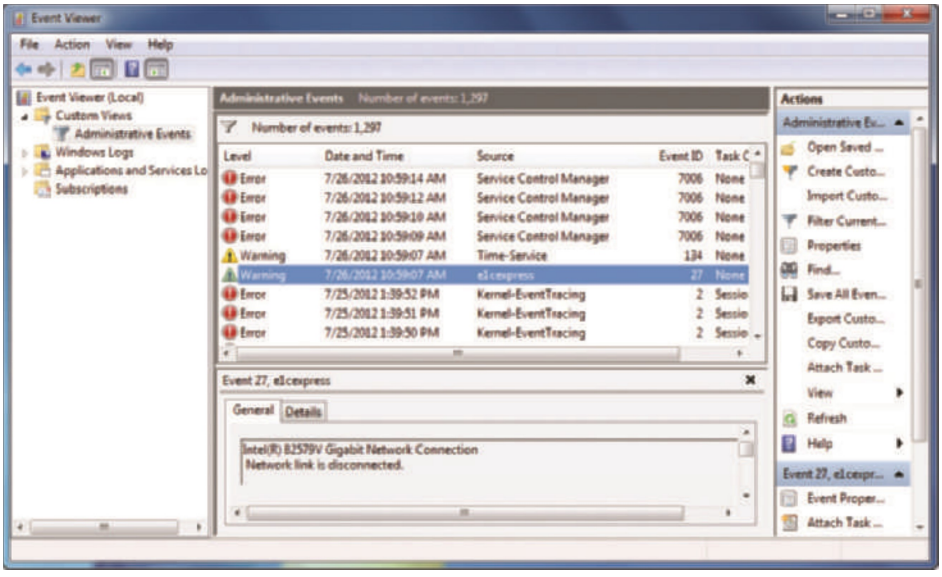

Figure 5-42 Use Event Viewer to find logs that can help with troubleshooting hardware problems

REAL PROBLEM 5-3 Troubleshooting a Hung System

A user complains to you that her system hangs for no known reason. After asking her a few questions, you identify these symptoms:

- The system hangs after about 15–20 minutes of operation.
- When the system hangs, it doesn't matter what application is open or how many applications are open.
- When the system hangs, it appears as though power is turned off: There are no lights, spinning drives, or other evidence of power.

You suspect overheating might be the problem. To test your theory, you decide to do the following:

1. You want to verify that the user has not overclocked the system. How do you do that?
2. You decide to check for overheating by examining the temperature of the system immediately after the system is powered up and then again immediately after the system hangs. Describe the steps you take to do this.
3. After doing the first two steps, you decide overheating is the cause of the problem. What are four things you can do to fix the problem?