Cooling Methods and Devices

Core 1 Objective

- 3.4

  Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

The processor, motherboard, memory modules, expansion cards, and other components in the case produce heat. If they get overheated, the system can become 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 section of the module, you learn about several methods to keep the system cool, beginning with these general rules to cool the inside of a computer case:

- **Keep the case closed.** This may seem counterintuitive, as you might think an open case allows for better airflow, but consider the dust that will clog your fans and how fans are designed to draw hot air out of a closed case. If airflow is disrupted, an open case is a temporary fix to an overheating computer and should not be used long term.
- **Clean the inside of the computer.** Dust and debris clog your computer. Dirt and dust cake on the equipment and essentially insulate the heat-sensitive components. Use a can of compressed air to blow clean the inside of the case and its components.
- **Move the computer.** If the computer is in a fairly dusty or warm space, the computer might overheat. If overheating is a problem, try moving the computer to a new area that is cleaner and cooler.

4-1a Processor Coolers, Fans, and Heat Sinks

Core 1 Objective

- 3.4

Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

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 Fahrenheit (32–43 degrees Celsius). The **cooler** (see Figure 4-1) sits on top of the processor and consists of a fan and a heat sink, which is made of metal and 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 module "Supporting Processors and Upgrading Memory."

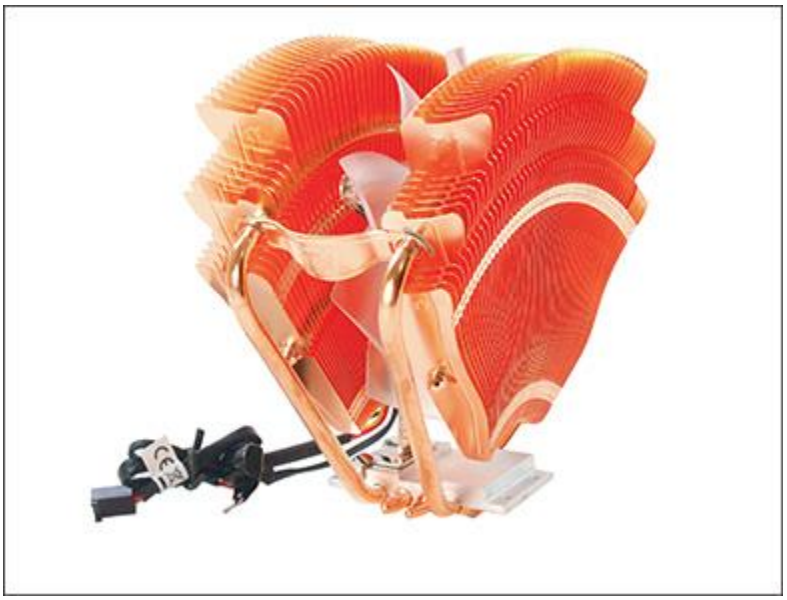
Figure 4-1

A cooler sits on top of a processor to help keep it cool

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 (thermaltakeusa.com) multisocket cooler shown in Figure 4-2 is made of copper and has an adjustable fan control.

Figure 4-2

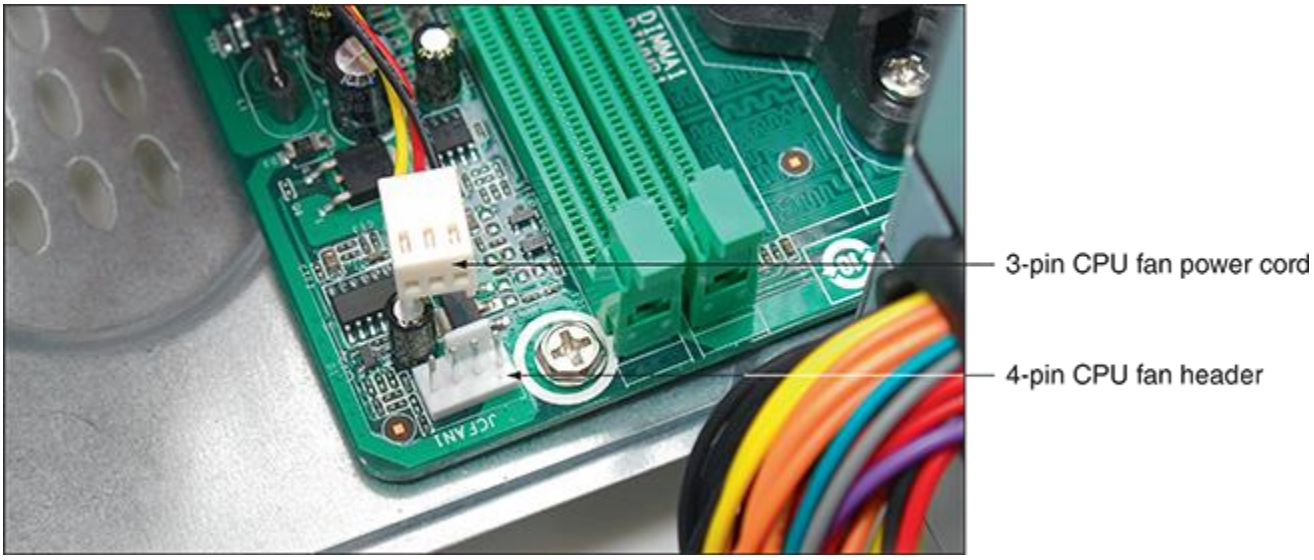
The Thermaltake V1 copper cooler is a multisocket cooler that fits several Intel and AMD sockets



To get its power, the cooler fan power cord connects to a 4-pin fan header on the motherboard (see Figure 4-3). 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), which 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 4-3

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



4-1b Thermal Compound and Thermal Pads

Core 1 Objective

- 3.4

Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

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. Thermal compound, also called **thermal paste** or thermal grease, is essential to effectively transfer heat by completely filling the gap between the processor and the cooling device. There are microscopic ridges on the surface of the contact plate on each component. The gel-like paste spreads in a thin layer to fill the gaps created by those ridges, removing air pockets that are inefficient at conducting heat.

An alternative to thermal paste is a thermal pad. A **thermal pad** is thicker than thermal paste and therefore fills larger gaps better. However, because thermal pads are less malleable, they still allow for air gaps. Thermal pads are more easily applied and are sized for the contact plate. Never use thermal pads and thermal compound at the same time, and never stack thermal pads together. Reusing thermal pads is not recommended.

Note 1

Temperature ratings show that thermal compound is generally better than thermal pads at conducting heat transfer and maintaining cooler temperatures for the processor.

4-1c Case Fans, Other Fans, and Heat Sinks

Core 1 Objective

- 3.4

Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

To prevent overheating, you can also install additional case fans. Most cases have one or more positions to hold a **case fan** to help draw air out of the case. Figure 4-4 shows holes on the rear of a case designed to hold a case fan.

Figure 4-4

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 more quietly than small fans.

Processors and video cards, also called graphics cards, are the two greatest 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 an expansion card to keep it cool. Another solution is to use a fan card mounted next to the graphics card. Figure 4-5 shows a PCI fan card. Be sure you select a 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 and for airflow.

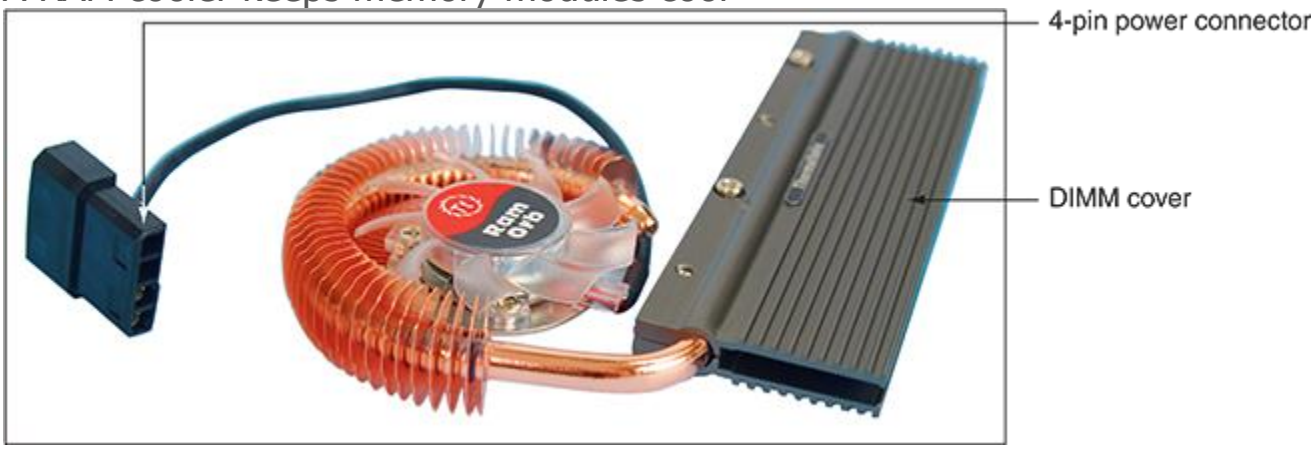
Figure 4-5

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

For additional cooling, consider a RAM cooler such as the one shown in Figure 4-6. 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 4-6 uses a Molex connector. If you need a different or extra power connector that isn't available on a power supply, you can use an adapter to change an unused SATA or Molex connector into the connector you need.

Figure 4-6

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.

4-1dLiquid Cooling Systems

Core 1 Objective

- 3.4

  Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

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, these systems are used by hobbyists attempting to overclock to the max a processor in a gaming computer because those types of high-powered systems tend to run hot. Liquid cooling systems tend to run more quietly than other cooling methods. They might include a PCIe card that has a power supply, temperature sensor, and processor to control the cooler.

In a liquid cooling system, 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, similarly to how a car radiator works. Figure 4-7 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.

Figure 4-7

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

4-2 Selecting a Power Supply

Core 1 Objective

- 3.5

Given a scenario, install or replace the appropriate power supply.

In the module "Taking a Computer Apart and Putting It Back Together," you learned about the different types of power connectors and how to uninstall and install a power supply unit (PSU). You might need to replace a power supply when it fails or if the power supply in an existing system is not adequate. When building a new system, you can purchase a computer case with the power supply already installed (see Figure 4-8), or you can purchase a power supply separate from the case.

4-2a Types and Characteristics of Power Supplies

Core 1 Objective

- 3.5

Given a scenario, install or replace the appropriate power supply.

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 dimensions 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 4-9.

Figure 4-9

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 one most used, especially in high-end gaming systems. Notice in Figure 4-9 that 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.

Note 2

To calculate wattage, know that the power in watts (W) is equal to the current in amps (A) times the voltage in volts (V): .

- **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 module "Taking a Computer Apart and Putting It Back Together." Table 4-1 lists some common connectors and the voltages they supply. A **modular power supply** includes detached power cables, sometimes called modular cable systems, that you can plug into connectors on the side of the unit. By using only the power cables you need, you eliminate unnecessary power cables, which can obstruct airflow inside the computer case.

Table 4-1

Power Supply Connectors and Voltages

Connector	Voltages	Description
SATA	+3.3 V, +5 V, +12 V	Power to SATA drives, 15-pin
Molex	+5 V, +12 V	Power to older IDE drives and used with some older SATA drives, 4-pin
24-pin P1	+3.3 V, +5 V, ±12 V	Newer main power connector to motherboard

Exam Tip

The A+ Core 1 exam expects you to know the voltage output of the power connectors listed in Table 4-1. Consider memorizing the table.

Note 3

If a power supply doesn't have the connector you need, you can probably buy an adapter to convert one connector to another. For example, Figure 4-10 shows an adapter that converts an older 20-pin connector to the newer 24-pin motherboard connector. Without this adapter, the motherboard would likely fry if you plugged a 20-pin cable into a 24-pin motherboard connector when the motherboard is drawing the full power of a 24-pin cable.

Figure 4-10

This adapter converts a 20-pin connector to a 24-pin motherboard connector

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

Note 4

Some power supplies are designed without fans so 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 in the range 110 to 120 V AC for the United States or in the range 220 to 240 V AC for other countries.
- **Extra features.** Consider the warranty of the power supply, the overall quality, and extra features based on the needs of the user:

- Some power supplies are designed to support two video cards used in a gaming computer. Two technologies used for multiple video cards are SLI by NVIDIA and Crossfire by AMD. If you plan to use multiple video cards, use a PSU that supports SLI or Crossfire.
- 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 (power factor correction) runs more efficiently and uses less electricity than other power supplies.

Commonly used with equipment found in server racks—and sometimes in high-end computers—a redundant power supply ensures there is no interruption in power. A **redundant power supply (RPS)** uses two identical power supplies, as shown in Figure 4-11. Only one of the power supplies is used at a time, and both are capable of supplying the full power requirements of the equipment. In the event that one power supply fails, the transition to the other is seamless to prevent any disruption to power to essential devices.

Figure 4-11

A redundant power supply uses two identical power supply units

4-2b How to Calculate Wattage Capacity

Core 1 Objective

- 3.5

Given a scenario, install or replace the appropriate power supply.

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 devices that get their power from ports connected to the motherboard.

Exam Tip

The A+ Core 1 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% 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 of power supply you need, add up the wattage requirements of all components, and then add 30%. Technical documentation for these components should give you the information you need. Table 4-2 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.

Table 4-2

To Calculate the Power Supply Rating You Need, Add Up Total Wattage

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

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 4-3 lists a few case and power supply manufacturers.

Table 4-3

Manufacturers of Cases and Power Supplies for Personal Computers

Manufacturer	Website
Antec	antec.com
Cooler Master	coolermaster.com
Corsair	corsair.com
EVGA	evga.com
PC Power & Cooling	pcpowerandcooling.com
Rosewill	rosewill.com
Seasonic	seasonic.com
Sentey	sentey.com
Silverstone	silverstonetek.com
Thermaltake	thermaltakeusa.com
Zalman	zalman.com

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.

4-3 Strategies to Troubleshoot Any Computer Problem

Core 1 Objective

- 5.1

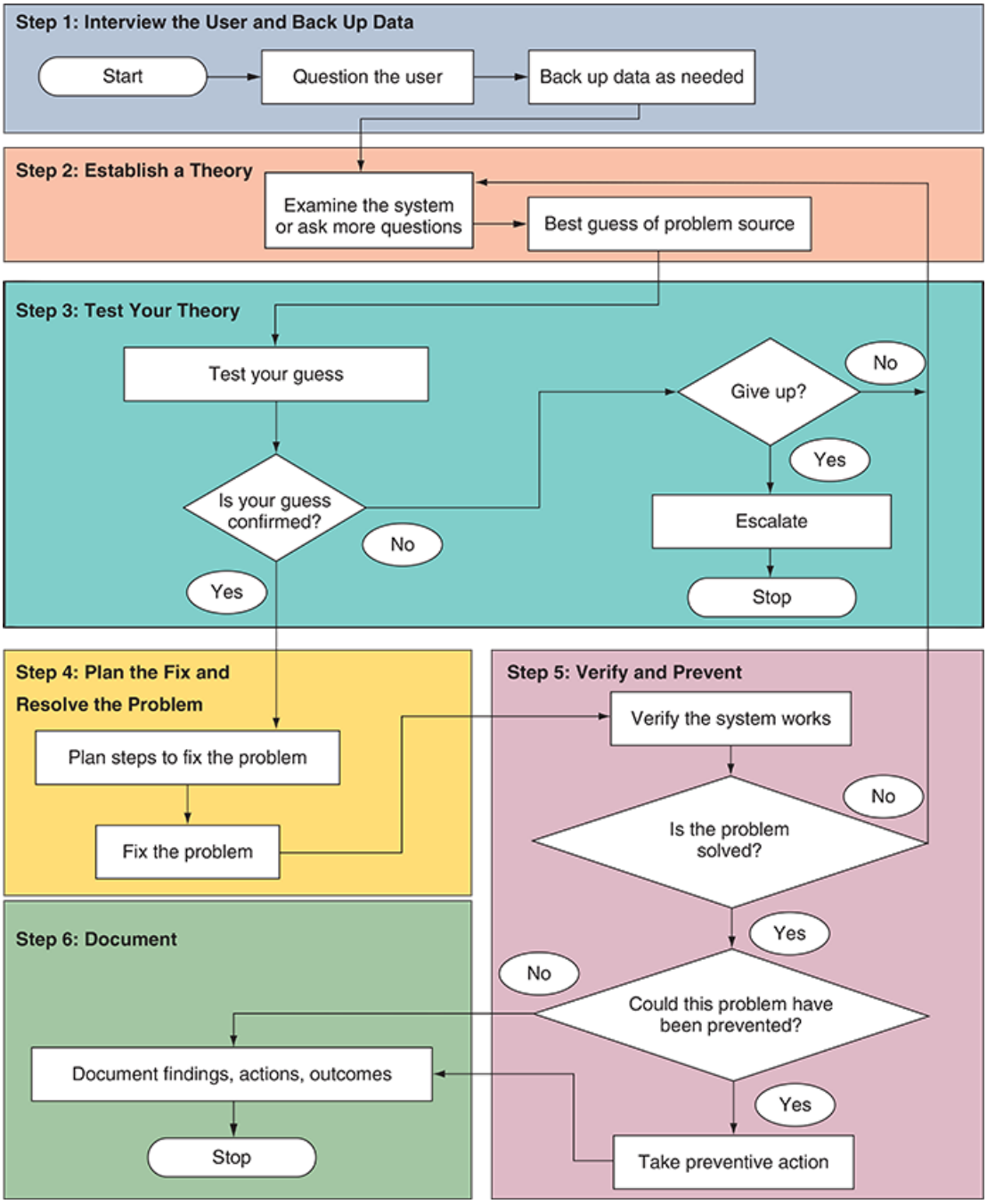
Given a scenario, apply the best-practice methodology to resolve problems.

When a computer doesn't work and you're responsible for fixing it, you should generally approach the problem first as an investigator and discoverer, always being careful not to compound the problem through your actions. If the problem seems difficult, see it as an opportunity to learn something new. Ask questions until you understand the source of the problem. Once you understand it, you're almost done because the solution most likely will be evident. If you take the attitude that you can understand the problem and solve it, no matter how deeply you must dig, you probably *will* solve it.

One systematic method used by most expert troubleshooters to solve a problem comprises the six steps diagrammed in Figure 4-12, which can apply to both software and hardware problems. As an IT technician, expect that you will develop your own style and steps for troubleshooting based on your own experiences over time.

Figure 4-12

A general approach to problem solving



Exam Tip

The A+ Core 1 exam expects you to know about all the aspects of troubleshooting theory and strategy and how to apply the troubleshooting procedures and techniques described in this section. Read A+ Core 1 Objective 5.1, and compare it with Figure 4-12. You'll find the objectives with this text.

Here are the steps:

1. 1
   Interview the user and back up data before you make any changes to the system.
2. 2
   Examine the system, analyze the problem, and make an initial determination of the source of the problem.
3. 3
   Test your theory. If the theory is not confirmed, form another theory or document what you've discovered so far. If you have run out of ideas, escalate the problem to someone higher in your organization with more experience or resources.
4. 4
   After you know the source of the problem, plan what to do to fix the problem, and then fix it.
5. 5
   Verify that the problem is fixed and that the system works. Take any preventive measures to make sure the problem doesn't happen again.
6. 6
   Document activities, outcomes, and what you learned.

Over time, a good IT support technician builds a strong network of resources they 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 assistance:

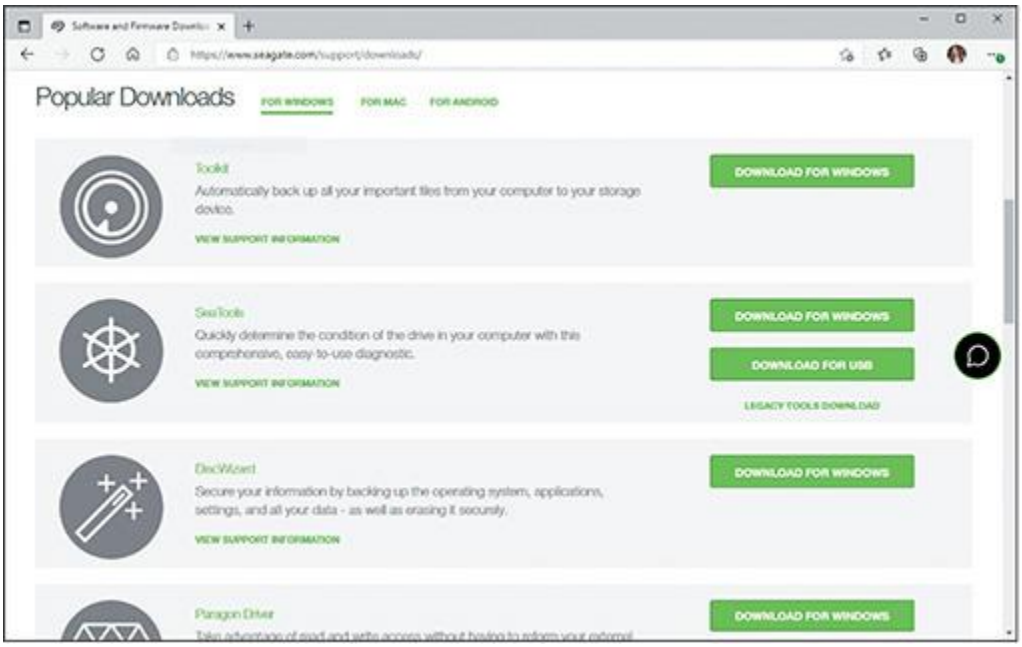
- **The web.** Do a web search on an error message, a short description of the problem, or the model and manufacturer of a device to get help. Check out the website of the product manufacturer or search a support forum. It's likely that other technicians have encountered the same problem and posted the 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 online what they know, but be careful—not all technical advice found online is correct or well intentioned.
- **Chat, forums, or email technical support.** Support from 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. Support from the manufacturer is considered the highest authority for the correct fix to a problem.

- **Manufacturer's diagnostic software.** Many hardware device manufacturers provide diagnostic software, which is available for download from their websites. For example, you can download Seagate Toolkit (to back up data), SeaTools for Windows (must be installed in Windows), or SeaTools Bootable (to create a bootable USB drive) and use the software to diagnose and fix problems with Seagate drives. See Figure 4-13. Search the support section of a manufacturer's website to find diagnostic software and guidelines for using it.

Figure 4-13

Download diagnostic software tools from a manufacturer's website



Note 5

Always check compatibility between utility software and the operating system (OS) you plan to use. Check with the computer owner before installing any new software.

- **User manuals.** Refer to the 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.** 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 technician who is more experienced or has access to more resources. (In an organization, this process is called escalating the problem.)

Now let's examine the process step by step. As you learn about these six steps, you'll also learn about 13 rules useful when troubleshooting. Here's the first rule.

Rule 1: Approach the Problem Systematically

When trying to solve the problem, start at the beginning and walk through the situation in a thorough, careful way. This rule is invaluable. Remember it and apply it every time. If you don't find the explanation to the problem after one systematic walk-through, then repeat the entire process. Check and double-check to find the step you overlooked the first time. Most problems with computers are simple, such as a loose cable or incorrect Windows setting. Computers are logical through and through. Whatever the problem is, it's also very logical. Also, if you are faced with more than one problem on the same computer, work on only one problem at a time. Trying to solve multiple problems at the same time can get too confusing.

4-3a Step 1: Interviewing the User and Backing Up Data

Core 1 Objective

- 5.1

Given a scenario, apply the best-practice methodology to resolve problems.

Every troubleshooting situation begins with interviewing the user if possible. If you have the opportunity to speak with the user, ask questions to help you identify the problem, how to reproduce it, and possible sources of the problem. Also ask about any data on the hard drive that is not backed up.

Exam Tip

The A+ Core 1 exam expects you to know how to interact with a user and know what questions to ask in a troubleshooting scenario without accusing or disrespecting the user.

Here are some questions that can help you learn as much as you can about the problem and its root cause:

1. Please describe the problem. What error messages, unusual displays, or failures did you see? (Possible answer: I see this blue screen with a funny-looking message on it that makes no sense to me.)
2. When did the problem start? Does the computer have a history of similar problems? (Possible answer: When I first booted after loading this neat screen saver I downloaded from the web.)

3. What was the situation when the problem occurred? (Possible answers: I was trying to start up my laptop. I was opening a document in Microsoft Word. I was using the web to research a project.)
4. What programs or software were you using? (Possible answer: I was using Microsoft Edge.)
5. What changes have recently been made to the system? For example, did you recently install new hardware or software or move your computer system? (Possible answer: Well, yes. Yesterday I moved the computer case across the room.)
6. Has there been a recent thunderstorm or electrical problem? (Possible answer: Yes, last night. Then when I tried to turn on my computer this morning, nothing happened.)
7. Have you made any hardware, software, or configuration changes? Have there been any infrastructure changes? (Possible answer: No, but I think my sister might have.)
8. Has someone else used your computer recently? (Possible answer: Sure, my son uses it all the time.)
9. Is there some valuable data on your system that is not backed up that I should know about before I start working on the problem? (Possible answer: Yes! Yes! My term paper! It's not backed up! You have to save that!)
10. Can you show me how to reproduce the problem? (Possible answer: Yes, let me show you what to do.)

Based on the answers you receive, ask more penetrating questions until you feel the user has given you all the information that might help you solve the problem. As you talk with the user, keep in mind rules 2, 3, and 4.

Rule 2: Establish Your Priorities

This rule can help make for a satisfied customer. Decide what your first priority is. For example, it might be to recover lost data or to get the computer back up and running as soon as possible. When practical, ask the user or customer for help deciding on priorities. For most users, data is the first priority unless they have a recent backup.

Rule 3: Beware of User Error

Remember that many problems stem from user error. If you suspect this is the case, ask the user to show you the problem and carefully watch what the user is doing. Be careful to handle a user error delicately because some people don't like to hear that they made a mistake.

Rule 4: Keep Your Cool and Don't Rush

In some situations, you might be tempted to act too quickly and to be drawn into the user's sense of emergency. But keep your cool and don't rush. For example, if a computer stops working and unsaved data is still in memory or if data on the hard drive has not been backed up, look and think carefully before you leap! A wrong move can be costly. The best advice is refrain from hurrying. Carefully plan your moves. Research the problem using documentation

or the web if you're not sure what to do, and don't hesitate to ask for help. Don't simply try something, hoping it will work, unless you've run out of more intelligent alternatives!

After you have talked with the user, be sure to back up any important data that is not currently backed up before you begin work on the computer. Here are three options:

- **Use Explorer to copy the data to another system.** If the computer is working well enough to boot to the Windows desktop, you can use Windows File Explorer to copy data to a flash drive, another computer on the network, or other storage media.
- **Move the hard drive to another system.** If the computer is not healthy enough to use Explorer, don't do anything to jeopardize the data. If you must take a risk with the data, let it be the user's decision to do so, not yours. When 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 4-14). Then turn on the computer. While you have the computer turned on, be very careful not to touch the drive or touch inside the case. Also, while a tower case is lying on its side like the one in Figure 4-14, don't use the optical drive.

  Figure 4-14

  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 a drive letter. Use Explorer or third-party software to copy files from this drive to the primary hard drive in this system or to other storage media. Then return the drive to the original system and turn your attention to solving the original problem.

Note 6

An easier way to temporarily install a hard drive in a system is to use a USB port. Figure 4-15 shows a USB-to-SATA converter kit. The SATA connector can be used for desktop or laptop hard drives because a SATA connector is the same for both. A USB-to-SATA converter is

handy when recovering data and troubleshooting problems with hard drives that refuse to boot.

Figure 4-15

Use a USB-to-SATA converter to recover data from a drive that has a SATA connector

- **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 may be worth it if getting the data back is a high priority. 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.

Exam Tip

The A+ Core 1 exam expects you to know the importance of making backups before you make changes to a system.

If possible, have the user verify that all important data is safely backed up before you continue to the next troubleshooting step.

Caution

Don't take chances with a user's important data. If the user tells you the data has already been backed up, ask them to verify that they can recover the data from the backup website or media before you assume the data is safely backed up.

If you're new to troubleshooting and don't want the user looking over your shoulder while you work, you might want to let them know you'd prefer to work alone. You can say something like, "Okay, I think I have everything I need to get started. I'll let you know if I have another question."

4-3bStep 2: Examining the System and Making Your Best Guess

Core 1 Objective

- 5.1

Given a scenario, apply the best-practice methodology to resolve problems.

You're now ready to start solving the problem. Rules 5 and 6 can help.

Rule 5: Make No Assumptions

This rule is the hardest to follow because there is a tendency to trust anything in writing and assume that people are telling you exactly what happened. But documentation is sometimes wrong, and people don't always describe events as they occurred, so do your own investigating. For example, if the user tells you that the system boots up with no error messages but that the software still doesn't work, boot for yourself. You never know what the user might have overlooked.

Rule 6: Try the Simple Things First

The solutions to most problems are so simple and obvious that we overlook them because we expect the problem to be difficult. Don't let the complexity of computers fool you. Most problems are easy to fix. Really, they are! To save time, check the simple things first, such as whether a power switch is not turned on or a cable is loose. Generally, it's easy to check for a hardware problem before you check for a software problem. For example, if a USB drive is not working, verify that the drive works on another port or another computer before verifying the drivers are installed correctly.

Follow this process to form your best guess (best theory) and test it:

1. **Reproduce the problem and observe for yourself what the user has described.** For example, if the user tells you the system is totally dead, find out for yourself. Plug in the power and turn on the system. Listen for fans and look for lights and error messages. Suppose the user tells you that Microsoft Edge will not open. Try opening it yourself to see what error messages might appear. As you investigate the system, refrain from making changes until you've come up with your theory for the source of the problem. Can you duplicate the problem? Intermittent problems are generally more difficult to solve than problems that occur consistently.
2. **Decide if the problem is hardware or software related.** Sometimes you might not be sure, but make your best guess. For example, if the system fails before Windows starts to load, chances are the problem is a hardware problem. If the user tells you the system has not worked since the lightning storm the night before, chances are the problem is electrical. If the problem is that Explorer will not open even though the Windows desktop loads, you can assume the problem is software related. In another example, suppose a user complains that their Word documents are getting corrupted. Possible sources of the problem might be that the user does not know how to save documents properly, the application or the OS might be corrupted, the computer might have a virus, or the hard drive might be intermittently failing. Investigate for yourself, and then decide if the problem is caused by software, hardware, or the user.

3. **Make your best guess as to the source of the problem, and don't forget to question the obvious.** Here are some practical examples of questioning the obvious and checking the simple things first:

    - The video doesn't work. Your best guess is the monitor cables are loose or the monitor is not turned on.
    - Excel worksheets are getting corrupted. Your best guess is the user is not saving the workbook files correctly.
    - The DVD drive is not reading a DVD. Your best guess is the DVD is scratched.
    - The system refuses to boot and displays the error that the hard drive is not found. Your best guess is internal cables to the drive are loose.

Rule 7: Become a Researcher

Following this rule is the most fun. When a computer problem arises that you can't easily solve, be as tenacious as a bulldog. Search the web, ask questions, read more, make some phone calls, and ask more questions. Take advantage of every available resource, including online help, documentation, technical support, and books such as this one. Learn to perform advanced searches using a good search engine on the web, such as google.com. What you learn will be yours to take to the next problem. This is the real joy of computer troubleshooting. If you're good at it, you're always learning something new.

If you're having trouble deciding what might be the source of the problem, keep rule 7 in mind, and try searching these resources for ideas and tips:

- 1.

  The specific application, operating system, or hardware you support must be available to you to test, observe, and study and to use to recreate a customer's problem whenever possible.

- 2.

  Verify any system or application changes by referring to the system or application event logs. Windows keeps comprehensive logs about the system, hardware, applications, and user activities; these logs can be viewed using Windows **Event Viewer**. Many applications keep logs of events or changes to the system or application. Some applications might pop up error messages, such as a low-disk-space error. Open the application log to evaluate the error more closely and to see if any more details are provided in the log.

- 3.

  Use a search engine to search the web for help. In your search string, include an error message, symptom, hardware device, or description of the problem. The chances are always good that someone else has had the same problem and has written about it online, and that someone else has presented a step-by-step solution. All you have to do

is find it! As you practice this type of web research, you'll get better and better at knowing how to form a search string and knowing which websites are trustworthy and present the best information. If your first five minutes of searching doesn't turn up a solution, please don't give up! It might take patience and searching for 20 minutes or more to find the solution you need. As you search, you'll most likely learn more and more about the problem, and you'll slowly zero in on a solution.

Note 7

To limit your search to a particular site when using google.com, use the site: parameter in the search box. For example, to search only the Microsoft site for information about the defrag command, enter this search string:

```
defrag site:microsoft.com
```

- 4.

  Some companies offer an expert system for troubleshooting. An **expert system** is software that is designed and written to help solve problems. It uses databases of known facts and rules to simulate human experts' reasoning and decision making. Expert systems for IT technicians work by posing questions about a problem to be answered by the technician or the customer. The response to each question triggers another question from the software until the expert system arrives at a possible solution or solutions. Many expert systems are "intelligent," meaning the system will record your input and use it in subsequent sessions to select more questions to ask and approaches to try. Therefore, future troubleshooting sessions on the same type of problem tend to zero in more quickly toward a solution.

4-3cStep 3: Testing Your Theory

Core 1 Objective

- 5.1

  Given a scenario, apply the best-practice methodology to resolve problems.

  As you test your theories, keep in mind rules 8, 9, 10, and 11.

Rule 8: Divide and Conquer

This rule is the most powerful. 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:

- In Windows, perform a clean boot to eliminate all nonessential startup programs and services as a possible source of the problem.
- Boot from a bootable DVD or flash drive to eliminate the Windows installation and the hard drive as the problem.
- Remove any unnecessary hardware devices, such as a second video card, optical drive, or even the hard drive. 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.

Rule 9: Write Things Down

Keep good notes as you're working. Notes will help you think more clearly. Draw diagrams. Make lists. Clearly and precisely write down what you're learning. If you need to leave the problem and return to it later, it's difficult to remember what you have observed and already tried. When the problem gets cold like this, your notes will be invaluable.

Rule 10: Don't Assume the Worst

When it's an emergency and your only copy of data is on a hard drive that is not working, don't assume that the data is lost. Much can be done to recover data. If you want to recover lost data on a hard drive, don't write anything to the drive; you might write on top of lost data, eliminating chances of recovery.

Rule 11: Reboot and Start Over

This is an important rule. Fresh starts are good, and they uncover events or steps that might have been overlooked. Take a break! Get away from the problem. Begin again.

> Most computer problems are simple and can be simply solved, but you do need a game plan. That's how Figure 4-16 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, the solution is often obvious.

Figure 4-16

Use this flowchart when first facing a computer problem


Begin troubleshooting startup.
Does the PC boot to the Windows desktop with no errors?
Yes
No
Problems after the boot are not covered in this flowchart.
Is important data on the hard drive backed up?
Yes
No
Move the hard drive to another computer and recover the data.
Is the screen blank?
Yes
No
Can you hear a spinning drive or fans or see lights?
Do you understand the error message on screen?
No
Yes
Yes
No
See the section, "Troubleshooting the Electrical System."
See Table 4-4 and the section, "Troubleshooting the Motherboard, Processor, and RAM."
Can you hear a single beep during the boot?
Has POST completed and BIOS/UEFI is now attempting to find a boot device?
No
Yes
Yes
No
See the section, "Troubleshooting the Motherboard, Processor, and RAM."
The problem is likely caused by video. See the module "Supporting I/O Devices."
See the section, "Troubleshooting the Motherboard, Processor, and RAM."
Is BIOS/UEFI attempting to boot from a device other than the hard drive?
Yes
No
Go into BIOS/UEFI setup and change the boot priority order. Then restart the system.
Does an error message indicate the system cannot find a boot device?
Yes
No
The problem is likely caused by windows. See the module "Troubleshooting Windows Startup."
The problem is likely caused by the hard drive. See the module "Supporting Hard Drives and Other Storage Devices."

As Figure 4-16 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 4-16 very carefully to get an idea of the symptoms that would cause you to suspect each subsystem.

Also, Table 4-4 provides general troubleshooting guidelines related to common symptoms and error messages, the likely sources of each type of problem, and tips for solving the problem.

Table 4-4

Symptoms or Error Messages Caused by Hardware Problems and What to Do about Them

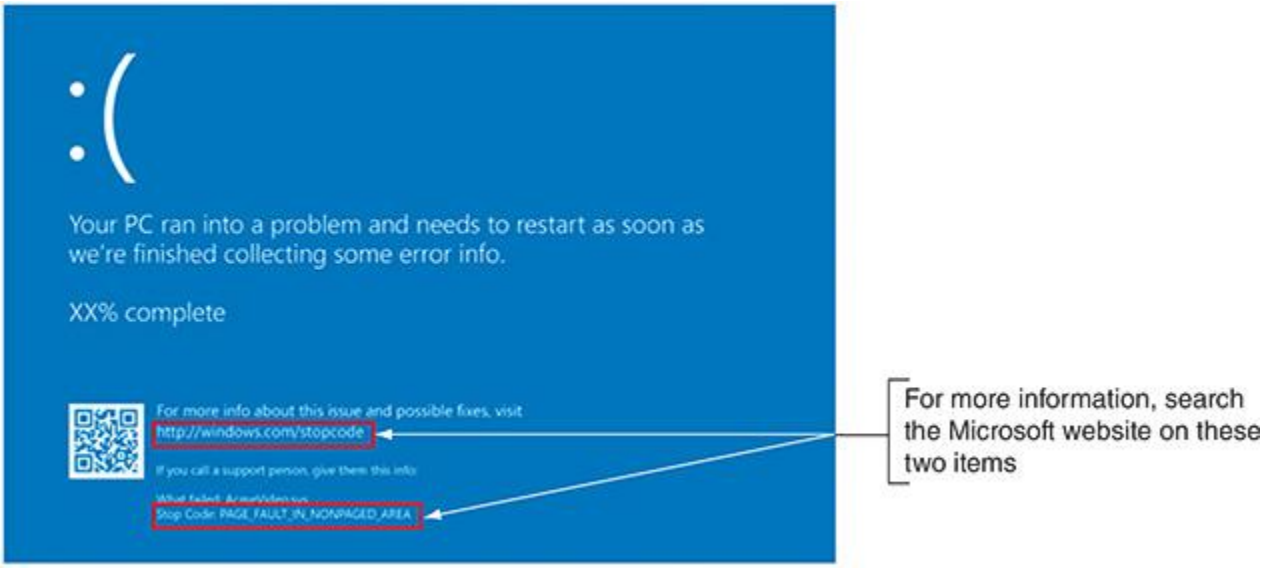
Symptom or Error Message	What to Do About the Problem
System shuts down unexpectedly	Try to find out what was happening at the time of the shutdowns to pinpoint an application or device causing the problem. Possible sources of the problem are overheating, faulty RAM, the motherboard, or the processor.
System shuts down unexpectedly and starts back up	Begin by checking the system for overheating. Is the processor cooler fan working? Go to BIOS/UEFI 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 4-17 shows an example of a BSOD error. 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 on a black background, such as the one shown in Figure 4-18, 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, also called an application crash. 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 BIOS/UEFI communicates POST errors as a series of beeps before it tests video. Search the website of the motherboard or BIOS/UEFI 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 4-5 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?

Symptom or Error Message	What to Do About the Problem
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 electrical. 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/UEFI 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.
System attempts to boot to the wrong boot device	Go into BIOS/UEFI 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.
Grinding noise	Most likely the noise is made by the ball bearings of a fan. Using compressed air to clean all the fans might fix the problem, but you might have to replace a failing fan.
Clicking noise	A clicking noise likely indicates the magnetic 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, the processor, or the 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.
Possible error messages: "No boot device available" "Hard drive not found" "Fixed disk error" "Invalid boot disk"	Startup BIOS/UEFI did not find a device to use to load the operating system. Make sure the boot device priority order is correct in BIOS/UEFI setup. Try booting from a bootable USB flash drive or DVD. If this works, begin troubleshooting the hard drive, which is covered in the module "Hard Drives and Other Storage Devices."

Symptom or Error Message	What to Do About the Problem
"Inaccessible boot device or drive" "Invalid drive specification"	
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 module "Troubleshooting Windows Startup."

Figure 4-17

Search the Microsoft website for information about a BSOD error

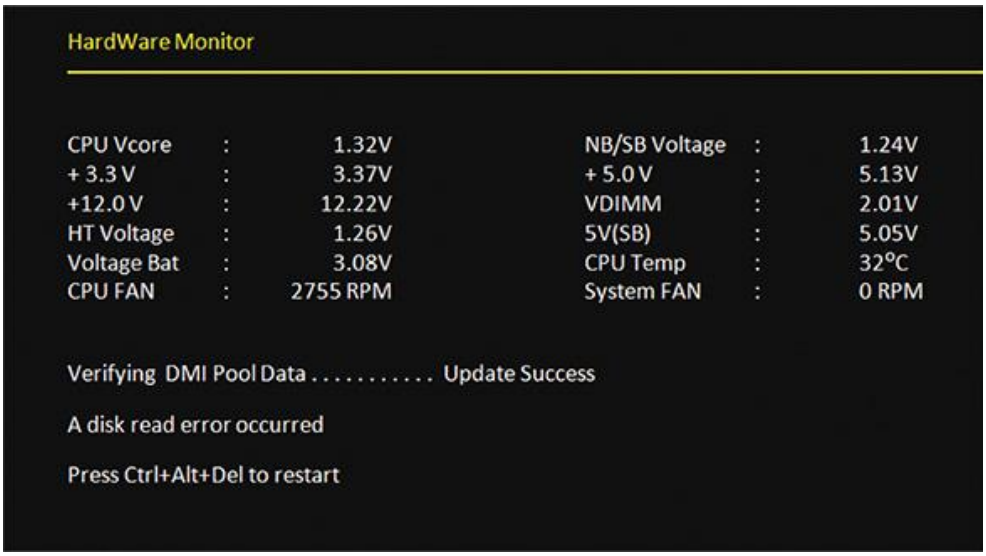


Exam Tip

The A+ Core 1 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.

Figure 4-18

A POST error message on a black screen shown early in the boot



Common Beep Codes and Their Meanings for Intel and Award BIOS

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

By the time you have finished Step 3, the problem might already be solved or you will know the source of the problem and will be ready to plan a solution.

4-3dStep 4: Planning Your Solution and then Fixing the Problem

Core 1 Objective

- 5.1

Given a scenario, apply the best-practice methodology to resolve problems.

Some solutions, such as replacing a hard drive or a motherboard, are expensive and time consuming. You need to carefully consider what you will do and the order in which you will do it. When planning and implementing your solution, keep rules 12 and 13 in mind.

Rule 12: Use the Least Invasive Solution First

As you solve computer problems, always keep in mind that you don't want to make things worse, so you should use the least invasive solution. You want to fix the problem in such a way that the system is returned to normal working condition with the least amount of effort and fewest changes. For example, don't format the hard drive until you've first tried to fix the problem without having to erase everything on the drive. As another example, don't reinstall Microsoft 365 until you have tried applying patches to the existing installation.

Rule 13: Know Your Starting Point

Find out what works and doesn't work before you take anything apart or try a possible fix. Suppose you decide to install a new anti-malware program. After the installation, you discover Microsoft 365 gives errors and you cannot print to the network printer. You don't know if the anti-malware program is causing problems or the problems existed before you began work. As often as possible, find out what works or what doesn't work before you attempt a fix.

Do the following to plan your solution and fix the problem:

1. Consider different solutions and select the least invasive one. When appropriate, talk with the user or owner about the best solution.
2. Before applying your solution, do your best to determine what works and doesn't work in the system so you know your starting point.
3. Fix the problem. This might be as simple as switching to a new monitor, or it might be as difficult as reinstalling Windows and applications software and restoring data from backups.

Hardware and software products generally have **technical documentation** available. If you don't find it on hand, know that you are likely to find user manuals and technical support manuals as .pdf files that can be downloaded from the product manufacturers' websites. These sites might offer troubleshooting and support pages, help forums, chat sessions, email support, and links to submit a troubleshooting ticket to the

manufacturer (see Figure 4-19). For Windows problems, the best websites to search are docs.microsoft.com and support.microsoft.com.

Figure 4-19

Search manufacturer websites for help with a hardware or software product

4-3e Step 5: Verifying the Fix and Taking Preventive Action

Core 1 Objective

- 5.1

Given a scenario, apply the best-practice methodology to resolve problems.

After you have fixed the problem, reboot the system and verify that all is well. Can you reach the Internet, use the printer, or use Excel in Microsoft 365? If possible, have the user check everything and verify that the job is done satisfactorily. If either of you finds a problem, return to Step 2 in the troubleshooting process to examine the system and form a new theory as to the cause of the problem.

After you and the user have verified all is working, ask yourself the question, "Could this problem have been prevented?" If so, go the extra mile to instruct the user, set Windows to automatically install updates, or do whatever else is appropriate to prevent future problems.

4-3f Step 6: Documenting What Happened

Core 1 Objective

- 5.1

Given a scenario, apply the best-practice methodology to resolve problems.

Good documentation helps you take what you learned into the next troubleshooting situation, train others, develop effective preventive maintenance plans, and satisfy any audits or customer or employer queries about your work. Most companies use call-tracking software for this purpose. Be sure to include initial symptoms, the source of the problem, your troubleshooting steps, and what you did to ultimately fix it. Make the notes detailed enough so that you or someone else can use them later, when solving similar problems.

For on-site support, a customer expects documentation about your services. Include in the documentation sufficient details broken down by cost of individual parts, hours worked, and cost per hour. Give the documentation to the customer at the end of the service, and keep a copy for yourself. For phone support, the documentation stays in-house.

Applying Concepts

Taking Good Notes

- **Est. Time:** 30 minutes
- **Core 1 Objective:** 5.1

Darnell had not been a good notetaker in school, and his ineffectiveness in this area was affecting his work. His manager, Jonathan, had been reviewing Darnell's notes in the ticketing system at the help desk and was not happy with what he saw. Jonathan had pointed out to Darnell more than once that his cryptic, incomplete notes with sketchy information would one day cause major problems.

On Monday morning, calls were hammering the help desk because a server had gone down over the weekend, and many internal customers were not able to get to their data. Darnell escalated one call from a customer named Andre to a tier-two help desk. Later that day, Asia, a tier-two technician, received the escalated ticket, and to her dismay, the phone number of the customer was missing. She called Darnell. "How am I to call this customer? You only have his first name, and these notes about the problem don't even make sense!" Darnell apologized to Asia, but the damage was done.

Two days later, an angry Andre calls the manager of the help desk to complain that his problem is still not solved. Jonathan listens to Andre vent and apologizes for the problem his help desk has caused. It's a little embarrassing to Jonathan to have to ask Andre for his callback information and to repeat the details of the problem. He gives the information to Asia, and the problem gets a quick resolution.

Discuss this situation in a small group, and answer the following questions:

1. If you were Darnell, what could you do to improve note-taking in the ticketing system?
2. After Asia called, do you think Darnell should have told Jonathan about the problem? Why or why not?
3. If you were Jonathan, how would you handle the situation with Darnell?

Have two students play the roles of Darnell and Jonathan when Jonathan calls Darnell into his office to discuss the call he just received from Andre. The other students in the group can watch and make suggestions as to how to improve the conversation.

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.

4-4 Troubleshooting the Electrical System

Core 1 Objectives

- 1.1

  Given a scenario, install and configure laptop hardware and components.

- 5.2

  Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

  Electrical problems can occur before or after the boot and can be consistent or intermittent. Repair technicians often 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 you can zero in on the source of an electrical problem as quickly as possible.

Applying Concepts

Exploring a Computer Problem

- **Est. Time:** 5 minutes
- **Core 1 Objective:** 5.2

Your friend Sharon calls to ask for your help with a computer problem. Her system has been working fine for more than 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, think of questions to ask your friend that will help you diagnose the problem.

The following are possible symptoms of a problem with the electrical system:

- 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.

The following list contains some questions you can ask and things you can do to solve a problem with the electrical system without opening the computer case. 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.
- If you hear a whine coming from the power supply when you first plug up power to a system, 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 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 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 turning on the computer 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 module.
- 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 an HP 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 front panel to 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 for frayed and burnt wires. Also look for cracked chips, chips with a burnt hole on top, or fine black dust around a chip. 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.

4-4a Problems That Come and Go

Core 1 Objective

- 5.2

Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

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 or files are corrupted.
- 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 may be 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 that 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 drives and the other devices 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; computers without cooling fans can quickly overheat. Usually just before a fan stops working, it hums or grinds, especially when the computer is first turned on. If this has just happened, replace the power supply. If the new fan does not work after you replace the power supply, 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 drawing too much power somewhere else in the system might cause the problem. To troubleshoot a nonfunctional fan, which might be a symptom of another problem and not of the fan itself, follow these steps:

    1. 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.
    2. Turn off the power and reconnect one card or drive at a time until you identify the device with the short.
    3. 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 that the motherboard needs to be replaced.

4-4b Power Problems with the Motherboard

Core 1 Objective

- 5.2

Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

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. Shake the case gently, and listen for loose screws or any other small pieces of a component.

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 module.

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.

Applying Concepts

Investigating a Computer Problem

- **Est. Time:** 15 minutes
- **Core 1 Objective:** 5.2

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

- 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 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.

4-4c Problems with Overheating

Core 1 Objective

- 5.2

Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

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 it 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).

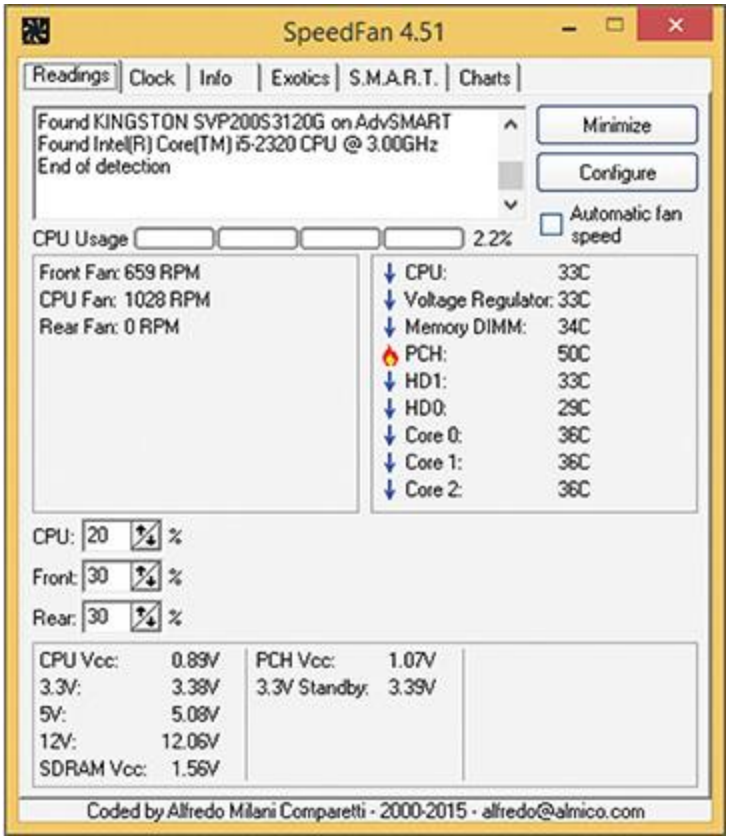
Here are some symptoms that a system is overheating:

- 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 grinding sound.
- You cannot feel air being pulled into or out of the case.

If you suspect overheating, go into BIOS/UEFI setup 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 4-20). A good website to download the freeware is filehippo.com/download_speedfan. Be careful not to download other freeware available on the site.

Figure 4-20

SpeedFan monitors fan speeds and system temperatures



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 BIOS/UEFI 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 components 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 4-21). To protect the fan, don't allow it to spin as you blow air into it. Overspinning might damage a fan.

Dust in this cooler fan can cause the fan to fail and the processor to overheat

Note 8

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 4-22). Orient the fan so 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 4-22

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. 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 4-23.

Figure 4-23

For optimum airflow, don't leave empty expansion slots and bays uncovered

6. Are cables in the way of airflow? Use cable ties to secure cables and cords so they don't block airflow across the processor or get in the way of fans turning. Figure 4-24 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 4-24

Use cable ties to hold cables out of the way of fans and airflow

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 air can circulate under the case and to reduce carpet dust inside the case. Many cases have a vent on the bottom front, and carpet can obstruct airflow into this vent (see Figure 4-25). Make sure drapes are not hanging too close to fan openings.

Figure 4-25

Keep a tower case off carpet to allow air to flow into the bottom air vent

- Verify that the cooler is connected properly to the processor. If it doesn't fit well, the system might not boot, and 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?
- 9.

  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 BIOS/UEFI 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 BIOS/ UEFI setup again. A significant difference between this reading and the first one you took after

running the computer for 10 minutes indicates an overheating problem.

- 10.

  Check BIOS/UEFI 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.

- 11.

  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 expansion 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 4-24, where you can see space between each drive installed in the system.

- 12.

  Flash BIOS/UEFI to update the firmware on the motherboard. How to flash BIOS/UEFI is covered in the module "All About Motherboards."

- 13.

  Thermal compound should last for years, but it will eventually harden and need replacing. If the system is several years old, replace the thermal compound.

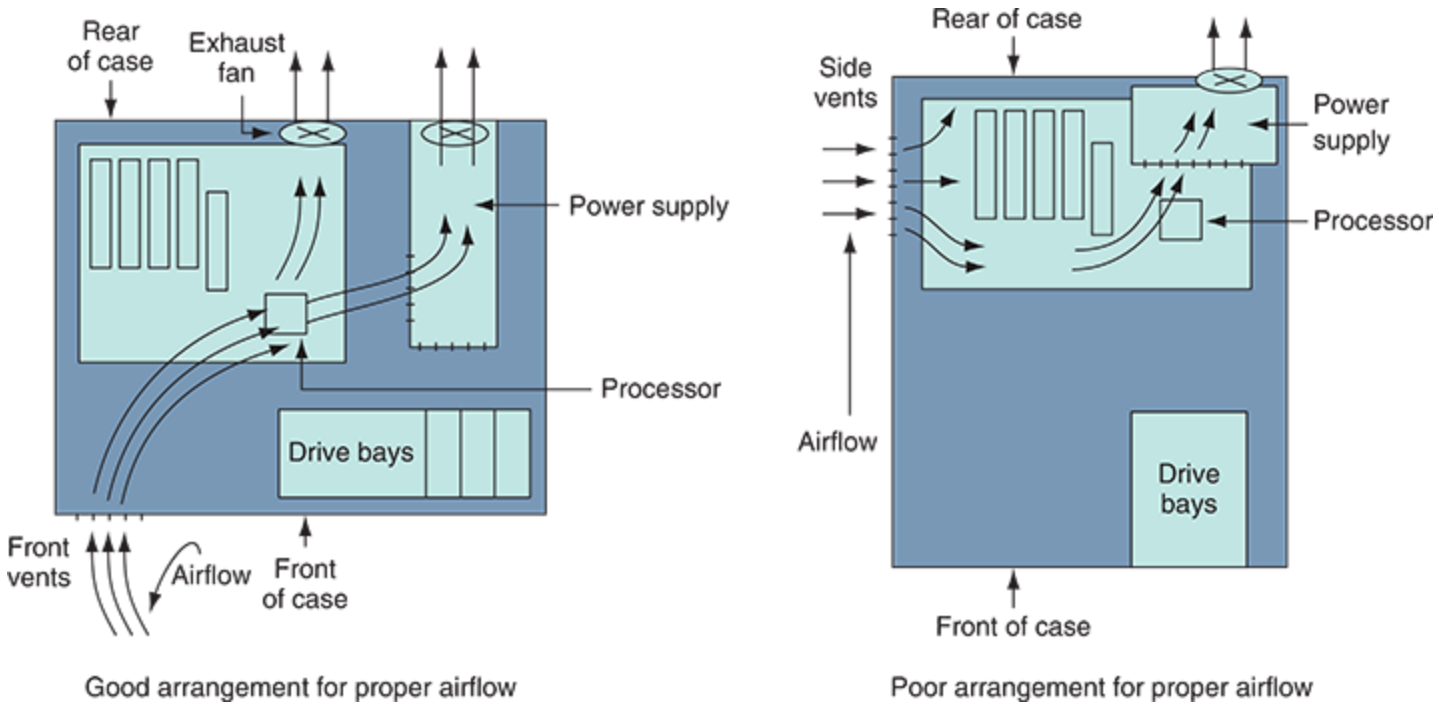
Exam Tip

The A+ Core 1 exam expects you to recognize that a given symptom is possibly power related 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 4-26 shows a good arrangement of vents and fans for proper airflow and a poor arrangement.

Figure 4-26

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, as shown in Figure 4-27. Compare that with the power supply in Figure 4-22, which has vents only on the front and not on the bottom.

Figure 4-27

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.

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.

4-4dProblems with Laptop Power Systems

Core 1 Objectives

- 1.1

  Given a scenario, install and configure laptop hardware and components.
- 5.2

Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

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 4-28 shows an AC adapter that has a green light indicating the adapter is receiving power.

Figure 4-28

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, you usually must release a latch first.

Note 9

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 that 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.
- 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. Involve the manufacturer for repair under warranty,
    2. replace the laptop, or
    3. use the laptop only when it's connected to power using the AC adapter.

Applying Concepts

Testing an AC Adapter

- **Est. Time:** 15 minutes
- **Core 1 Objective:** 5.2

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 centerpin connector:

1. 1
   Unplug the AC adapter from the computer, but leave it plugged into the electrical outlet.
2. 2
   Most laptops run on 19 V DC, but a few run on 45 V DC. To be on the safe side, set the multimeter to measure voltage in the range of 1–200 V DC. 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 4-29).

Figure 4-29

To use a multimeter to test this AC adapter, place the red probe in the center of the connector and the black probe on the outside

1. 3
   The voltage range should be plus or minus 5% 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.

4-5 Troubleshooting the Motherboard, Processor, and RAM

Core 1 Objective

- 5.2

  Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

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, such as a network port, is not working, you might be able to disable that component in BIOS/UEFI setup and install a card to take its place.

Exam Tip

The A+ Core 1 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. They replaced the hard drive, with no change. They replaced the motherboard next. The computer booted up with no problem; they were delighted, until it failed again. Later they discovered that a faulty power supply had damaged the original motherboard. When they 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.

The following symptoms can indicate that a motherboard, processor, or memory module is failing:

- 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 sluggish, 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/UEFI settings, and other software and hardware components as the source of the problem:

1. 1
   If an error message appears, google the error message. Pay particular attention to search results about the motherboard or processor manufacturer or Microsoft websites. Search forums for information about the error.

2. 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. 3
   A memory module might be failing. In Windows use the **Memory Diagnostic Tool** to test memory. Even if Windows is not installed, you can still run the tool by booting the system from the Windows setup flash drive or DVD. How to use the Memory Diagnostic Tool is coming up later in this module.

   Note 10
   Besides the Windows Memory Diagnostic Tool, you can use the Memtest86+ utility to test installed memory modules. Check the site memtest86.com to download this program.
4. 4
   Suspect the problem is caused by an application or by Windows. In Windows, Device Manager is the best tool to check for potential hardware problems.

5. 5
   In Windows, check Event Viewer logs for a record about a hardware or application problem. You learn to use Event Viewer in a project at the end of this module.

6. 6
   In Windows, download and install any Windows updates or patches. These updates might solve a hardware or application problem.

7. 7
   Ask yourself what has changed since the problem began. If the problem began immediately after installing a new device or application, uninstall it.

8. 8
   A system that does not have enough RAM can sometimes appear to be unstable. Using the Windows About window, find out how much RAM is installed, and compare that with the recommended amounts. Consider upgrading RAM.

9. 9
   The BIOS/UEFI might be corrupted or have wrong settings. Check BIOS/UEFI setup. Have settings been tampered with? Is the CPU speed set incorrectly, or is it overclocked? Reset BIOS/UEFI setup to restore default settings.

10. 10
    Disable any quick booting features in BIOS/UEFI so you get a thorough report of POST. Then look for errors reported on the screen during the boot.

11. 11
Flash BIOS/UEFI to update the firmware on the board.

12. 12
Check the motherboard manufacturer's website for diagnostic software that might identify a problem with the motherboard.

13. 13
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.

14. 14
If an onboard port or device isn't working, but the motherboard is stable, follow these steps:

1. Verify that 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.
2. Go into BIOS/UEFI setup and verify that the port is enabled.
3. Check Device Manager and verify that Windows recognizes the device or port with no errors. For example, Device Manager shown in Figure 4-30 reports the onboard Bluetooth device is disabled. Try to enable the device.

Figure 4-30

Device Manager reports a problem with an onboard device

1.

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

2. 15
Suspect the problem is caused by a failing hard drive. How to troubleshoot a failing drive is covered in the module "Hard Drives and Other Storage Devices."

3. 16
Suspect the problem is caused by overheating. How to check for overheating is covered earlier in this module.

4. 17
Verify that the installed processor is supported by the motherboard. Perhaps someone has installed the wrong processor.

Applying Concepts

Using the Windows Memory Diagnostic Tool

- **Est. Time:** 30 minutes
- **Core 1 Objective:** 5.2

Errors with memory are often difficult to diagnose because they can appear intermittently and might be mistaken as sluggish performance, 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 Memory Diagnostic tool. Use one of these two methods to start the utility:

- **Use the mdsched.exe command in Windows.** To open a command prompt window from the Windows desktop, enter the **`cmd`** command in the Windows search box. In the command prompt window, enter **`mdsched.exe`** and press **Enter**. A dialog box appears (see Figure 4-31) and asks if you want to restart and run the test now or run the test on the next restart.

Figure 4-31

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 USB drive or DVD to test memory for errors. Follow these steps:

1. 1

   If necessary, change the boot priority order in BIOS/UEFI setup to boot first from the optical drive or USB drive. Boot from the Windows setup DVD or USB drive.

2. 2

   On the opening screen for Windows, select your language and click **Next**. On the next screen (see Figure 4-32), click **Repair your computer**. Next choose **Troubleshoot**. The Advanced options screen appears.

Figure 4-32

The opening menu when you boot from Windows 10 setup media

3

On the Advanced options screen (see Figure 4-33), choose **Command Prompt**. In the command prompt window, enter the **`mdsched.exe`** command.

Figure 4-33

The Windows 10 Advanced options screen launched from Windows 10 setup media

To find the results, open **Event Viewer** and search for "MemoryDiagnostics-Results," and click **Find Next**. These event logs report memory errors or no memory errors detected. If the tool reports memory errors, replace all memory modules installed on the motherboard.

Note 11

You learn to use Event Viewer in a project at the end of this module.

Applying Concepts

Using Device Manager to Delete the Driver Store

- **Est. Time:** 15 minutes
- **Core 1 Objective:** 5.2

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 also tell Windows to 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. First sign in to Windows using an account with administrative privileges and then follow these steps:

1. 1
   To open Device Manager from the Windows desktop, right-click **Start** and click **Device Manager**. Device Manager opens. Alternately, you can enter devmgmt.msc in the Windows search box or in a command prompt window.

2. 2
   Right-click the device and click **Properties** in the shortcut menu. Click the **Driver** tab and click **Uninstall Device**. In the Uninstall Device box, check **Delete the driver software for this device**, and click **Uninstall**. See Figure 4-34. 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 4-34

Use Device Manager to uninstall the drivers and delete the driver store for a device

Also know that if the check box is missing in the Uninstall Device dialog box, the drivers are embedded in Windows, and you cannot delete the driver store for these devices. Examples of these devices are an optical drive, a hard drive, and a 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.

4-5aWindows Startup Repair

Core 1 Objective

- 5.2

Given a scenario, troubleshoot problems related to motherboards, RAM, CPU, and power.

Many continuous restart errors can be solved by performing a Startup Repair process. The **Startup Repair** utility restores many of the Windows files needed for a successful boot. After several restarts, Windows will try to automatically run the Startup Repair process. If Startup Repair does not automatically start or does not fix the problem, try running it from Windows setup media.

Follow these steps to run Startup Repair from the Windows setup USB drive or DVD:

1. 1
If necessary, change the boot priority order in BIOS/UEFI setup to boot first from the USB drive or optical drive. Boot from the Windows setup USB drive or DVD.

2. 2
On the opening screen, select your language and click **Next**. On the next screen, click **Repair your computer**. Next, choose **Troubleshoot**. The Advanced options screen appears (refer back to Figure 4-33). On the Advanced options screen, choose **Startup Repair**, and select your operating system. Windows will attempt to repair the system and restart to the Windows desktop.

If you have tried to repair Windows, checked BIOS/UEFI settings, 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. 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. 1
Check that all the system power and data cables are securely connected. Try reseating all expansion cards and DIMM modules.

2. 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. 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 it does, replace one

component at a time until the problem returns and you have identified the component causing the trouble.

4. 4
   Try using a POST diagnostic card. It might offer you a clue as to which component is giving a problem.

5. 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. 6
   Exchange the processor.

7. 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

- **Est. Time:** 15 minutes
- **Core 1 Objective:** 5.2

Benafsha complained to DeShaun, 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, DeShaun suspected Benafsha 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 Benafsha most often used and even reinstalled Windows, but the problems persisted.

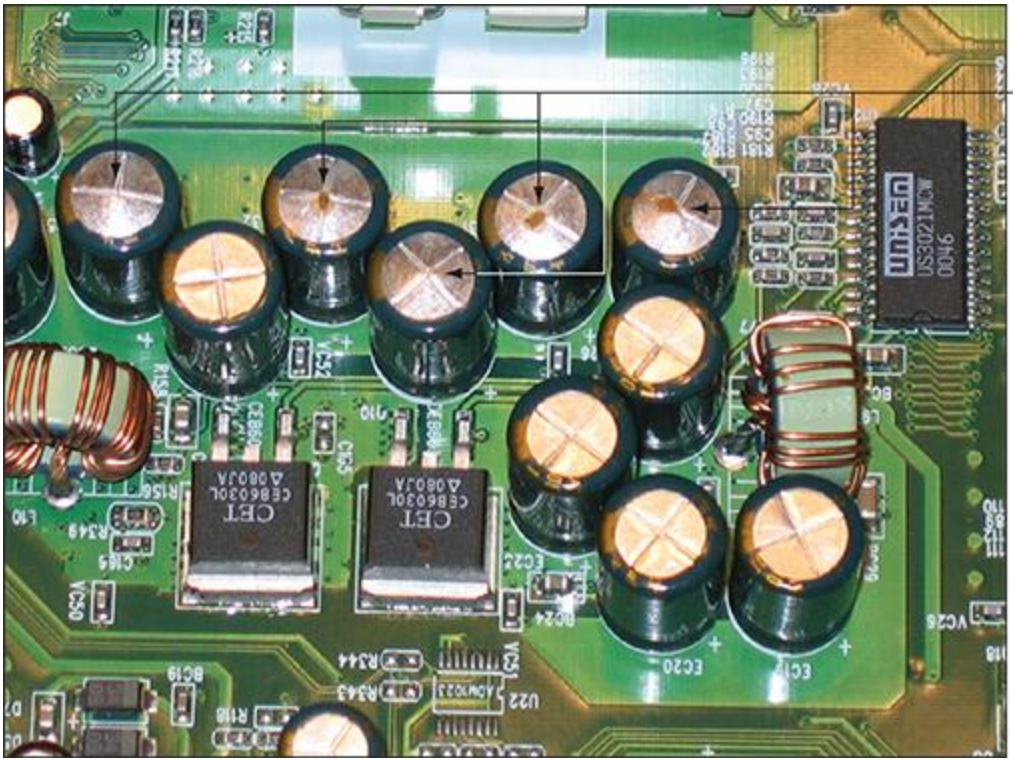
Note 12

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

DeShaun began to suspect a hardware problem. Carefully examining the motherboard revealed the source of the problem: failing capacitors. Look carefully at Figure 4-35 and you can see five bad **discolored capacitors** with bulging heads. (Know that sometimes a leaking capacitor can also show crusty corrosion at its base.) When DeShaun replaced the motherboard, the problems went away.

Figure 4-35

These five bad capacitors have bulging and discolored heads



Lessons Learned

- **Est. Time:** 15 minutes
- **Core 1 Objective:** 5.2

Kiara 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 Kiara takes to troubleshoot the problem:

1. 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. 2
   She plugs in the system and presses the power button again. Still all she hears is the faint whine.

3. 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! Kiara jumps back in dismay.

4. 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. She quickly turns off the switch and unplugs the power cord. She does not want to lose another power supply!

5. 5
   Next, Kiara calls technical support of the company that sold her the computer parts. A very helpful technician listens carefully to the details and tells Kiara 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 Kiara hangs up the phone, she begins to think that the problem might be with the motherboard installation.

6. 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. 7
   Kiara 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. 8
   Kiara purchases a new power supply and motherboard and this time carefully uses spacers in every hole used by the motherboard screws. Figure 4-36 shows one installed spacer and one ready to be installed. The system comes up without a problem.

Figure 4-36

Spacers installed in case holes keep the motherboard from causing a short

In evaluating her experience with her first computer build, Kiara 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 grows because you learn you can face a serious problem and solve it.

Module Review

4-6a Module 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 systems.

- 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 before purchase 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%. The wattage provided by the +12 V rail is also important.

Strategies to Troubleshoot Any Computer Problem

- The six steps in the troubleshooting process are (1) interview the user and back up data, (2) examine the system and form a theory of probable cause (your best guess), (3) test your theory, (4) plan a solution and implement it, (5) verify that everything works and take appropriate preventive measures, and (6) document what you did and the final outcome.
- 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 laptops, 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 keep a system from overheating.
- A laptop battery is considered a field replaceable unit (FRU) that pertains to the power system.
- Use a multimeter to check the voltage output of a laptop AC adapter.

Troubleshooting the Motherboard, Processor, and RAM

- BIOS/UEFI 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 BIOS/UEFI 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, a Windows error, or overheating.
- A POST diagnostic card can troubleshoot problems with the motherboard.

Module Review

4-6c Thinking Critically

These questions are designed to prepare you for the critical thinking required for the A+ exams and may use information from other modules and the web.

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?

    1. 250 W
    2. 1000 W
    3. 700 W
    4. 150 W

3. You upgrade a faulty PCIe video card to a recently released higher-performing card. Now the user complains that Windows hangs a lot and gives errors. Which is the most likely source of the problem? Which is the least likely source?

    1. A component of the computer is overheating.
    2. Windows does not support the new card.
    3. The drivers for the card need updating.
    4. Memory is faulty.

4. What should you immediately do if you turn on a computer and smell smoke or a burning odor?

1. Unplug the computer.
2. Dial 911.
3. Find a fire extinguisher.
4. 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?

1. The video card or onboard video
2. The monitor or monitor cable
3. Windows startup
4. 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?

1. Replace the surge protector.
2. Replace the power supply.
3. Wait about 30 minutes for the system to cool down and try again.
4. Install an additional fan.

8. You own a small computer repair company, and a customer comes to you with a laptop that will not boot. After investigating, you discover the hard drive has crashed. What should you do first?

1. Install a hard drive that's the same capacity and speed as the original.
2. Ask the customer's advice about the capacity of the drive to install, but select a drive that's the same speed as the original drive.
3. Ask the customer's advice about the capacity and speed of the new drive to install.
4. If the customer looks like they can afford it, install the largest capacity and fastest drive the system can support.

9. You have replaced a power supply in a client's computer. However, while you were working, you tripped on the power cord and bent the prongs on the plug so that it now is difficult to plug in an outlet. The customer receives the computer, notices the bent prongs, and begins shouting at you. What do you do first? Second?

1. Explain to the customer you are sorry but that it was an accident.
2. Listen carefully to the customer and don't get defensive.
3. Apologize and offer to replace the power cord.
4. Tell the customer not to speak to you like that.

10. As a help desk technician, list four good detective questions to ask if a user calls to say, "My computer won't turn on."
11. 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?

12. How do you determine the wattage capacity needed by a power supply?
13. You've decided to build a new gaming computer, and you are researching which power supply to buy. Which component in a high-end gaming computer is likely to draw the most power? What factor in a power supply do you need to consider to ensure this component has enough wattage?
14. Your friend Alexus calls to ask for help with her computer. She says when she first turns on the computer, she doesn't hear a spinning drive or fan or see indicator lights, and the monitor is blank. Is the problem hardware related or software related?
15. Which two components in a system might make a loud whining noise when there is a problem? Why?
16. Your manager assigns you a trouble ticket that says a computer is randomly shutting off after about 15 minutes of use. You have a theory that the computer is overheating. What utility program can you use to read system temperatures?
17. What are two reasons to tie cables up and out of the way inside a computer case?
18. You suspect a component in a computer is fried. You remove any unnecessary hardware devices one by one to narrow down where the problem exists. Which step in the troubleshooting process is this?

Module Review

4-6e Real Problems, Real Solutions

Real Problem 4-1

Replacing a Power Supply

- **Est. Time:** 30 minutes
- **Core 1 Objective:** 3.5

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 that 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 4-2

Using Event Viewer to Troubleshoot a Hardware Problem

- **Est. Time:** 15 minutes
- **Core 1 Objective:** 5.1

Just about anything that happens in Windows is recorded in Event Viewer (eventvwr.msc). You can find information about 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. Then start looking in the other logs if you can't find an event you know happened. Do the following to practice using Event Viewer:

1. 1
   Enter **`eventvwr.msc`** in the Windows search box or in a command prompt window. 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. 2
   Disconnect the network cable.

3. 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 4-37 shows Event Viewer's Administrative Events view. Describe the details of the event about the network cable.

   Figure 4-37

   Use Event Viewer to find logs that can help you troubleshoot hardware problems

4. 4
   Tinker around with other hardware on your computer. What actions did you take that triggered a Warning or Error event in Event Viewer?

Hands-On Project 4-3

Troubleshooting a Hung System

- **Est. Time:** 30 minutes
- **Core 1 Objective:** 5.2

A user complains to you that the system hangs for no known reason. After asking them 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 which 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?

Cooling Methods and Devices

- If the processor, motherboard, memory modules, expansion cards, and other components overheat, the system can get unstable and components can fail or be damaged
- Devices used to cool a system are CPU and case fans, coolers, heat sinks, and liquid cooling systems
- General rules to cool the inside of a computer case include the following:
  - Keep the case closed
  - Clean the inside of the computer
  - Move the computer

Processor Coolers, Fans, and Heat Sinks

- Computer systems use a cooling assembly designed for a specific processor to keep temperatures below the processor maximum temperature
- Good processor coolers maintain a temperature of 90-110 degrees F (32-43 degrees C)
- The **cooler** sits on top of the processor and consists of a fan and heat sink
  - **Heat sink** uses fins that draw heat away from processor
- The fan blows drawn heat away from CPU unit
  - The fan gets power by using a 4-pin fan header on the motherboard

Thermal Compound and Thermal Pads

- Thermal compound (thermal paste) transfers heat by completely filling the gap between the processor and the cooling device
- An alternative is a thermal pad, which is thicker than thermal compound and fills larger gaps better
  - They are more easily applied and are sized for the contact plate
- Never use thermal pads and thermal compound at the same time
- Never stack thermal pads together

Case Fans, Other Fans, and Heat Sinks (1 of 2)

- 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**
  - Large fans tend to perform better than small fans
- Some graphics (video) cards come with a fan
  - Fan cards can be mounted next to graphics cards
    - Be sure to select a fan card that fits the expansion slot you plan to use
- A RAM cooler clips over a DIMM memory module
  - It may be powered by a SATA or 4-pin Molex power connector

Case Fans, Other Fans, and Heat Sinks (2 of 2)

Figure 4-4 Install a case fan on the rear of this case to help keep the system cool

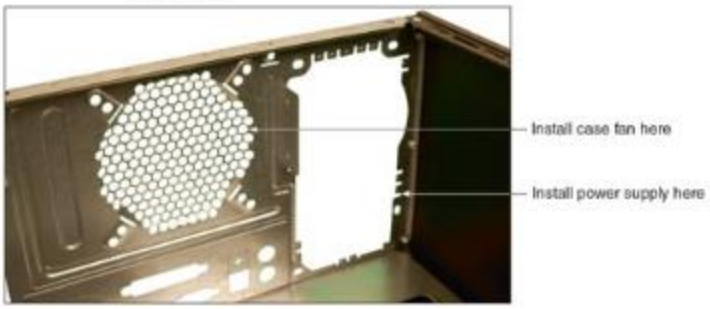


Figure 4-4 Install a case fan on the rear of this case to help keep the system cool

Liquid Cooling Systems

Figure 4-7 A liquid cooling system pumps liquid outside and away from components where fans can then cool the liquid

Source: Courtesy of Thermaltake (USA) Inc.

Figure 4-7 A liquid cooling system pumps liquid outside and away from components where fans can then cool the liquid

Selecting a Power Supply

- Reasons to replace a power supply include the following:
  - A power supply fails
  - A power supply in an existing system is not adequate
- When building a new system, you have the following options:
  - You can purchase a computer case with the power supply already installed
  - You can purchase a power supply separate from the case

Types and Characteristics of Power Supplies (1 of 2)

- Important power supply feature considerations include the following:
  - The form factor determines the power supply size
  - Wattage ratings (listed in the documentation and the side of the power supply)
  - Number and type of connectors
  - Fans inside the PSU
  - Dual voltage options
  - Extra features
- A **redundant power supply (RPS)** uses two identical power supplies

Types and Characteristics of Power Supplies (2 of 2)

Figure 4-9 Consider the number and type of power connectors and the wattage ratings of a power supply

Figure 4-9 Consider the number and type of power connectors and the wattage ratings of a power supply

How to Calculate Wattage Capacity

- When deciding what wattage capacity you need, consider the following:
  - The total wattage requirements of all components inside case as well as all USB devices that get power from ports connected to the motherboard
- Keep these two points in mind when selecting the correct wattage:
  - Video cards draw the most power
  - The power supply should be rated 30% higher than expected needs
- To know what size of power supply you need, add up the wattage requirements and add 30%

Knowledge Check Activity 4-1: Answer

- 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?

- **Answer: c. 700 W**
- **Use Table 4-2 to add up the approximate wattage: 300W + 30 W + (30 W × 3) + 50 W = 470 W. Then add 30% to get 611 W. The closest answer that meets this requirement is 700 W.**

Strategies to Troubleshoot Any Computer Problem (2 of 3)

- Steps for troubleshooting include the following:
  - Interview the user and back up data before you make any changes to the system
  - Examine the system, analyze the problem, and make an initial determination of the source of the problem
  - Test your theory
  - After you know the source of the problem, plan what to do to fix the problem and then fix it
  - Verify that the problem is fixed and that the system works
  - Document activities, outcomes, and what you learned

Strategies to Troubleshoot Any Computer Problem (3 of 3)

- Some troubleshooting resources include the following:
  - The web
  - Chat, forums, or email technical support
  - Manufacturer's diagnostic software
  - User manuals
  - Technical associates in your organization
- There are 13 troubleshooting rules found throughout the next section
- **Rule 1: Approach the Problem Systematically**

Step 1: Interviewing the User and Backing Up Data (1 of 2)

- Here are some questions you can ask when interviewing the user:
  - Can you describe the problem? What error messages, unusual displays, or failures did you see?
  - When did the problem start?
  - What was the situation when the problem occurred?
  - What programs or software were you using?
  - What changes have been recently made to the system?
  - Has there been a recent thunderstorm or electrical problem?
  - Have you made any hardware, software, or configuration changes?

Before beginning work on a computer, always ask the user if the data is backed up, if the computer is under warranty, and what recent changes have been made to the computer. The cost of the computer is not relevant in most situations.

Step 1: Interviewing the User and Backing Up Data (2 of 2)

- As you talk with the user, keep in mind rules 2, 3, and 4:
  - **Rule 2: Establish Your Priorities**
  - **Rule 3: Beware of User Error**
  - **Rule 4: Keep Your Cool and Don't Rush**
- Be sure to back up any important data before you begin work on the computer
- Options to backup:
  - Use Explorer to copy the data to another system
  - Move the hard drive to another system
  - Hire a professional file recovery service

Step 2: Examining the System and Making Your Best Guess

- Rules 5 and 6 can help as you start solving the problem:
  - **Rule 5: Make No Assumptions**
  - **Rule 6: Try the Simple Things First**
- Follow this process to form your best guess:
  - Reproduce the problem and observe for yourself what the user has described
  - Decide if the problem is hardware- or software-related
  - Make your best guess as to the source of the problem, and don't forget to question the obvious
- **Rule 7: Become a Researcher**

Step 3: Testing Your Theory (1 of 3)

- As you test your theories, keep in mind rules 8 through 11:
  - **Rule 8: Divide and Conquer**
  - **Rule 9: Write Things Down**
  - **Rule 10: Don't Assume the Worst**
  - **Rule 11: Reboot and Start Over**

Step 4: Planning Your Solution and then Fixing the Problem (1 of 2)

- When planning and implementing your solution, keep rules 12 and 13 in mind:
  - **Rule 12: Use the Least Invasive Solution First**
  - **Rule 13: Know Your Starting Point**
- Do the following to plan your solution and fix the problem:
  - Consider different solutions and select the least invasive one
  - Before applying your solution, do your best to determine what works and doesn't work in the system so you know your starting point
  - Fix the problem
- If you do not have **technical documentation** on hand, search the product manufacturers' websites

Step 5: Verifying the Fix and Taking Preventative Action

- After fixing the problem, reboot the system and verify that all is well
- Can you do the following:
  - Reach the Internet?
  - Use the printer?
  - Use Microsoft Office?
- If possible, have the user check everything and verify that the job is done satisfactorily
- After verifying all is working, ask the following question:
  - Could this problem have been prevented?

Step 6: Documenting What Happened

- Good documentation helps you to do the following:
  - Take what you learned into the next troubleshooting situation
  - Train others
  - Develop effective preventative maintenance plans
  - Satisfy any audits or customer or employee queries about your work
- Be sure to include the following items in your documentation:
  - Initial symptoms
  - Source of the problem
  - Your troubleshooting steps

Interview

Backup data

Examine system, est. theory

Fix

Verify fix

Document

A knowledge base and a ticket-tracking program both provide organized, accessible, and resilient storage of computer and network information. A sticky note might get lost or thrown away, and is not secure. An email might be difficult to find later when you or a co-worker needs the information.

A Class C fire extinguisher is designed specifically for use on electrical fires. Class A fire extinguishers are designed for ordinary combustibles such as wood and paper. Class B fire extinguishers are designed for flammable liquids such as grease and oil. Class D fire extinguishers are designed for combustible metals such as magnesium.

A working hard drive from another computer will already have an operating system installed. Also, if it works in the broken computer, then we know the broken computer's hard drive is the problem. The storage capacity of the working hard drive is not relevant, and the hard drive's compatibility with the broken computer is not related to whether the hard drive works in the working computer.

Troubleshooting the Electrical System (1 of 3)

- The following are possible symptoms of a problem with the electrical system:
  - The computer appears “dead” – no indicator lights and no spinning drive or fan
  - The computer sometimes locks up during booting
  - Error codes or beeps occur during booting
  - You smell burnt parts or odors
  - The computer powers down at unexpected times
  - The computer appears dead, but you hear a whine coming from the power supply

Troubleshooting the Electrical System (2 of 3)

- Here are some questions to ask and things to do to solve a problem with the electrical system:
  - 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
  - Is the power cord plugged in?
  - Is the power outlet controlled by a wall switch?
  - Are any cable connections loose?

Troubleshooting the Electrical System (3 of 3)

- If you need to look inside the computer case turn off the computer, unplug it, press the power button to drain residual power, and open the case
- Next, do the following:
  - Check all power connections from the power supply to the motherboard and drives
  - If you smell burnt parts, carefully search for shorts and for frayed and burnt wires
  - If you suspect the power supply is bad, test it with a power supply tester

Problems That Come and Go (1 of 2)

- Symptoms that might indicate an intermittent problem with the electrical system after the boot include the following:
  - The computer stops or hangs for no reason
  - Memory errors appear intermittently
  - Data is written incorrectly to the hard drive or files are corrupted
  - 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

Problems That Come and Go (2 of 2)

- Here is what to do to eliminate the electrical system as the source of an intermittent problem:
  - Consider the power supply is inadequate
  - Suspect the power supply is faulty
  - The power supply fan might not work
    - Do not operate the computer if the fan does not work

Power Problems with the Motherboard

- A short might occur if some component on the motherboard makes improper contact with the chassis
- For some cases, check for missing standoffs
  - A missing standoff most often causes these improper connections
- Shake the case gently and listen for loose screws
- Shorts in the circuits on the motherboard might also cause problems
  - Look for damage on the bottom of the motherboard

Problems with Overheating (1 of 5)

- Here are some symptoms of overheating:
  - System hangs or freezes at odd times or after the boot starts
  - Windows BSOD (blue screen of death) 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
- If you suspect overheating, go into BIOS/UEFI setup and view the temperature monitors for the system
- You can purchase a temperature sensor that will sound an alarm when the inside of the case is too hot

Problems with Overheating (2 of 5)

- Things to do to solve overheating include the following:
  - If system hangs, go into BIOS/UEFI setup and find the CPU screen that reports temperature (should not exceed that recommended by the CPU manufacturer)
  - Use compressed air, a blower, or antistatic vacuum to remove dust from the power supply and vents
  - Check airflow inside the case to see if fans are running (may need to replace a fan)
  - Install extra fans if case will hold them
  - Install a chassis air guide that guides air to the processor
  - To improve airflow, replace missing faceplates and expansion slot covers

Problems with Overheating (4 of 5)

- Things to do to solve overheating include the following (continued):
  - Place case so that there are a few inches of space on both sides and the top of the case
  - Verify the cooler is connected properly to the processor
  - After closing the case, leave system off for at least 30 minutes
  - Check UEFI/BIOS setup to see if the processor is being overclocked (can cause system to overheat)
  - Have too many peripherals been installed inside the case? Try to leave an empty slot between each card
  - Flash UEFI/BIOS to update firmware on motherboard

Problems with Laptop Power Systems (1 of 2)

- A laptop can be powered by an AC adapter or a battery pack
- Today's batteries use **lithium ion** technology
- Most AC adapters are capable of **auto-switching** from 110 V to 220 V AC power
- Some mobile users like to keep an extra battery on hand in case the first one uses up its charge

Problems with Laptop Power Systems (2 of 2)

- If power is not getting to the system or the battery indicator light is lit, do the following:
  - Verify the AC adapter is plugged into a live electrical outlet
  - Check if the AC adapter's plug is secure in the outlet
  - Check connections on both sides of AC adapter transformer
  - Check the connection at the DC jack on the laptop
- If the battery is not charging when AC adapter is plugged in, the problem might be with the battery or the motherboard

Success Tips

roubleshooting the Motherboard, Processor, and RAM (1 of 5)

- The following symptoms can indicate that a motherboard, processor, or memory is failing:
  - The system begins to boot but then powers down
  - An error message is displayed during the boot
  - The system reports less memory than installed
  - The system becomes unstable, hangs, or freezes
  - Intermittent Windows or hard drive errors occur
  - Components on the motherboard or devices connected to it don't work
- Check the simple things first

Troubleshooting the Motherboard, Processor, and RAM (2 of 5)

- Follow these steps to find source of problem:
  - 1. If an error message appears, google the error message
  - 2. Run antivirus software to check for viruses
  - 3. A memory module might be failing, use the **Memory Diagnostic Tool** to test memory
  - 4. Check for potential hardware problems using Device Manager
  - 5. Check Event Viewer logs for a record about a hardware or application problem
  - 6. In Windows, download and install any Windows updates or patches
  - 7. If problem began after a change or new install, uninstall device or application

Troubleshooting the Motherboard, Processor, and RAM (3 of 5)

- Follow these steps to find source of problem (continued):
  - 8. Use the Windows About window to find out how much RAM is installed (consider upgrading if not enough)
  - 9. Check BIOS/UEFI setup to ensure proper settings
  - 10. Disable any quick booting features in BIOS/UEFI
    - Then look for errors reported during the boot
  - 11. Flash BIOS/UEFI to update firmware on the board
  - 12. Check the motherboard manufacturer's website for diagnostic software
  - 13. Update all drivers of motherboard components that are not working

Troubleshooting the Motherboard, Processor, and RAM (4 of 5)

- Follow these steps to find source of problem (continued):
  - 14. If an onboard port or device is not working:
    - Verify the problem is not with the device using the port
    - Go into BIOS/UEFI setup and verify the port is enabled
    - Check Device Manager and verify Windows recognizes device or port with no errors
    - Update motherboard drivers for this device or port from manufacturer's website
    - Use a loop-back plug to test the port
    - Disable the port in BIOS/UEFI setup and install an expansion card

Troubleshooting the Motherboard, Processor, and RAM (5 of 5)

- Follow these steps to find source of problem (continued):
  - 15. Suspect the problem is a failing hard drive
  - 16. Suspect the problem is caused by overheating
  - 17. Verify the installed processor is supported by the motherboard

Windows Startup Repair

- Many continuous restart errors can be solved by performing a Startup Repair process
- The **Startup Repair** utility restores many of the Windows files needed for a successful boot
- Follow these steps to run Startup Repair from the Windows setup USB drive or DVVD:
  - 1. If necessary, change the boot priority order in BIOS/UEFI setup to boot first from the optical drive or USB drive
  - 2. On the opening screen, select your language and click Next. On the next screen, click **Repair your computer**. Next, choose **Troubleshoot**
    - On the Advanced Options screen, choose **Startup Repair**

Knowledge Check Activity 4-2: Answer

- 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?

- **Answer: c. Wait about 30 minutes for the system to cool down and try again.**
- **Given the computer symptoms described, you might suspect possible overheating. The first step is to get accurate temperature readings after cooldown and again later, when the system is overheated.**

Summary

- Now that the lesson has ended, you should 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

About

Your PC is monitored and protected.

See details in Windows Security

Device specifications

Device name	Lab-LT4
Processor	Intel(R) Core(TM)2 Duo CPU T8300 @ 2.40GHz 2.40 GHz
Installed RAM	4.00 GB
Device ID	DB329F77-F7D7-40C8-83D3-F9C30ED3555F
Product ID	00330-80000-00000-AA703
System type	64-bit operating system, x64-based processor
Pen and touch	No pen or touch input is available for this display

Copy

Rename this PC

Windows specifications

Edition	Windows 10 Pro
Version	21H1
Installed on	11/14/2021
OS build	19043.1526
Experience	Windows Feature Experience Pack 120.2212.4170.0

You have just upgraded your case fan. When installing it you notice that the old fan used 3 pins and that your new one has four pins. This isn't a problem because the intended fan header has four pins. What is the extra pin for?
Module 4 Power Supplies and Troubleshooting Computer Problems

Fan Control

When considering the metals used in your processor cooler, which is the best overall choice?
Module 4 Power Supplies and Troubleshooting Computer Problems

Copper w/ Al fins

Which of the choices provided would best utilize the slim design of the cooler in this image?
Module 4 Power Supplies and Troubleshooting Computer Problems

Video Card

Which would be the LEAST likely application for the heat sink in this image?
Module 4 Power Supplies and Troubleshooting Computer Problems

Processor

The cooler in this image would be best suited as a _____ fan.
Module 4 Power Supplies and Troubleshooting Computer Problems

Household element – dust

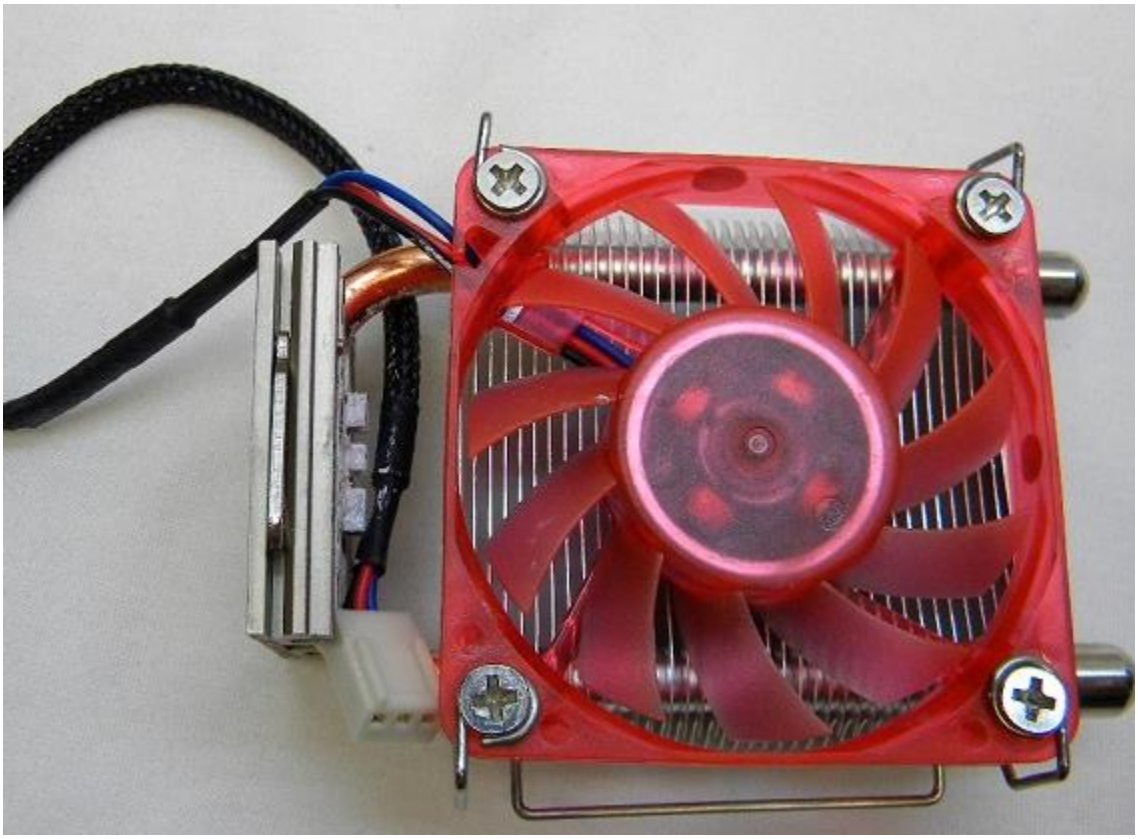
Extra pin – fan control

Passive = fanless, obstacle is size

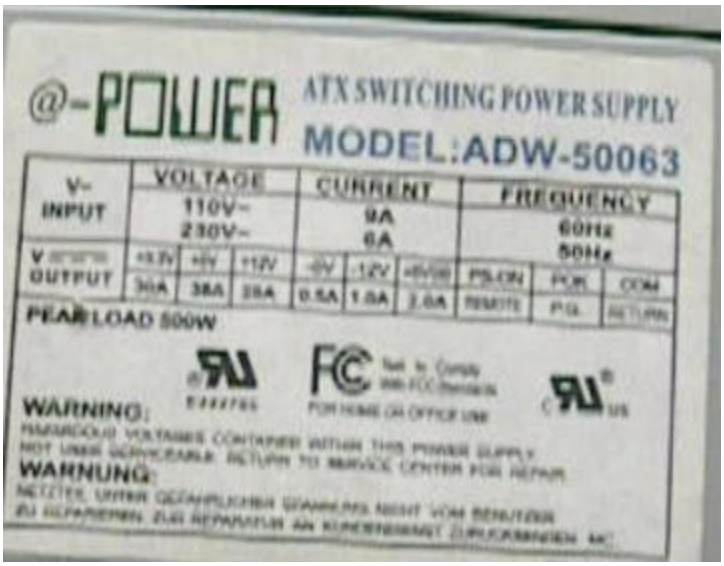
Header = motherboard component for fan power

your cpu fan operates on which voltage: +12V

copper is better heat conductor



Chipset Cooler



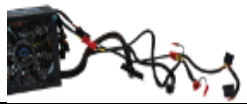
Atomic particles that make up the metal plates of a heat sink are constantly moving. When heat is added to the heat sink, the atomic particles move faster, conducting heat away from the source and out into the air. The heat sink's fans and brackets are stationary, and a heat sink does not use liquid coolant.

« Zalman FX100	« Cryorig H7	« Deepcool Captain120EX
 Type: Fanless CPU cooler Noise level: 0 dBA	 Type: Tower cooler Noise level: 10 – 25 dBA	 Type: Liquid cooling system Noise level: 17.6 – 31.3 dBA
No noise, heat sink, paste	Fan, sink, paste	Overclocking,
ASRock Heat sink	Geil Ram Heat sink	Cryorig h7 Fan, heat sink, paste
Cpu fan Sink, fan, paste		

Noise is measured in decibels. A computer's clock speed is measured in Megahertz. Data storage capacity can be measured in gigabytes. Power is measured in watts.

You can determine the voltages provided to a power supply connector by looking at the colors of the wires on the connector. Orange wires carry +3.3 V Red wires carry +5 V White wires carry -5 V Yellow wires carry +12 V Blue wires carry -12 V Black wires are ground wires Identify the voltage output of each of these standard power supply connectors. Note that some connectors are capable of more than one voltage output.	Molex red +5, yellow +12, black ground EPS yellow +12, black ground PCIe yellow +12, black ground ATX 20+4 Pin orange +3.3, red +5, white -5, yellow +12, blue -12, black ground SATA orange +3.3, red +5, yellow +12, black
Watts (W) – Rate of Energy Transfer (cooling a CPU)	

A watt is energy per unit of time and is used to measure power. Joule is a measure of mechanical energy transferred to an object Hertz is one cycle per second and is used to measure clock speed Volt is a measure of the difference of electrical potential.	

EVGA power supply  Max power: 430W Connector types: Fixed	**HEC power supply**  Max power: 300W Connector types: Fixed	**Raidmax power supply**  Max power: 530W Connector types: Fixed & modular
necessary. The 80 PLUS certification ensures the power supply meets objective standards. And using a modular or semi-modular power supply will reduce clutter inside the case.		

A dusty fan can cause overheating, which might make the system hang or freeze, and the fan might start making louder noises than usual. The amount of memory reported and the functionality of the hard drive will not usually be affected by a dusty fan.	The 4+4 pin 12V power connector is found on modern motherboards near the processor socket to connect from the power supply to provide supplemental power for a high-end processor beyond what it receives directly from the motherboard. The 6+2 pin PCIe connector is typically used for a high-end graphics card. The 20+4 pin P1 connector is used to power all modern motherboards. The 4 pin Molex connector is used to power older storage devices such as magnetic hard drives and optical drives.
The slightly smaller SATA connector is replacing Molex. Berg is an older connector. USB is not used for direct connections to the power supply. PCIe power connectors are used for video cards.	Device Manager is the primary Windows tool for managing hardware. Memory Diagnostics is used to test memory. Disk Defragmenter is used to rewrite data in a continuous chain. System Configuration is used to make changes to the startup process.
The chkdsk utility is an easy way to check a hard drive for errors without opening the computer case. Complete the following steps to run a chkdsk scan, fix errors, and recover any readable information from damaged sectors on this computer: • Right-click **Start** and click **Command Prompt (Admin)**. • Type `chkdsk C: /r` and press **Enter**. • Tell the computer to check the hard drive on the next restart. • Close the command prompt window and restart the computer.	Action Center and Reliability Monitor both provide some error reporting in Windows. Steps Recorder records actions taken while recording is turned on. System Restore is used to restore the computer to a previous state.

To see the results after the computer reboots, complete the following steps: • Right-click **Start** and click **Event Viewer**. • Expand the **Windows Logs** menu. • Right-click **Application**. • Click **Filter Current Log**. • In the **Event Sources** field, select **Chkdsk** and **Wininit**. Click **OK**.	Windows offers both Command Prompt and PowerShell command-line utilities. Computer Management provides a single console to access several tools. Mstsc is used to remotely log into another computer. Event Viewer is used to view events that have been logged in Windows.
Let's use Memory Diagnostics to test the installed memory cards. Complete the following steps: • Open a command prompt window. (You do not need administrative privileges this time.) • Type `mdsched.exe` and press **Enter**. • Tell the computer to restart now and check for problems.	Failing memory is an easy and inexpensive problem to fix. Just like when you replace tires on a car, it's best to replace memory cards in pairs. This computer only contains one pair of memory cards, so let's replace both of them: • Power down the computer and open the case. • Remove the memory cards. • Install compatible replacements on the motherboard. Next, you would test the memory again, and also run the computer for a while to see if it still exhibits any symptoms.
Damage to the motherboard could easily be caused by a mildly damaged power supply that hasn't yet noticeably damaged anything else, and power supplies are much less expensive to replace than having to replace the new motherboard again. The hard drive, graphics card, and case don't usually cause damage directly to the motherboard without first showing other significant symptoms.	Electrical Short in system Damaged AC Adapter (easiest to test first) Failing Motherboard Damaged power supply