CHAPTER 1

Introduction to Computers

In this chapter, you'll learn about some basic computer-related concepts that are important for any technician to understand. For example, different numbering systems are often unfamiliar to many people, but don't underestimate their importance in understanding how a computer works. The Numbering Systems section lays the foundation for topics in many future chapters. This chapter also includes information about cases, fans, and power supplies—core hardware computer components that often require periodic maintenance by technicians. Last, you'll learn about some basic safety issues and tools you can use when maintaining computers.

IMPORTANT

Have you read page xliv?

It contains valuable information regarding the skills you need to pass the exams.

Exam 220-801 objectives in this chapter:

- 1.2 Differentiate between motherboard components, their purposes, and properties.
  - Power connections and types
  - Fan connectors
- 1.8 Install an appropriate power supply based on a given scenario.
  - Connector types and their voltages
    - SATA
    - Molex
    - 4/8-pin 12v
    - PCIe 6/8-pin
    - 20-pin
    - 24-pin
    - Floppy
  - Specifications
    - Wattage
    - Size
    - Number of connectors

        - ATX
        - Micro-ATX
    - Dual voltage options
- 5.1 Given a scenario, use appropriate safety procedures.
    - ESD straps
    - ESD mats
    - Self-grounding
    - Equipment grounding
    - Personal safety
        - Disconnect power before repairing PC
        - Remove jewelry
        - Lifting techniques
        - Weight limitations
        - Electrical fire safety
    - Compliance with local government regulations
- 5.2 Explain environmental impacts and the purpose of environmental controls.
    - MSDS documentation for handling and disposal
    - Temperature, humidity level awareness and proper ventilation
    - Power surges, brownouts, blackouts
        - Battery backup
        - Surge suppressor
    - Protection from airborne particles
        - Enclosures
        - Air filters
    - Dust and debris
        - Compressed air
        - Vacuums
    - Component handling and protection
        - Antistatic bags
    - Compliance to local government regulations

Exam 220-802 objectives in this chapter:

- 4.2 Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU and power with appropriate tools.
  - Common symptoms
    - No power
    - Overheating
    - Loud noise
    - Intermittent device failure
    - Smoke
    - Burning smell
  - Tools
    - Multimeter
    - Power supply tester

REAL WORLD **DIRTY FANS MIGHT SOUND LIKE JET ENGINES**

Not too long ago, a friend was complaining to me about a computer she had. She said she was going to have to replace it because it was just too loud and slow. I took a look, or perhaps I should say a listen, and sure enough it reminded me of being next to a jet engine. However, I knew how to solve this problem.

I bought a can of compressed air, took the computer outside, and removed the case. There was dust gunked up in just about every vent and throughout the inside of the computer. I methodically blew out all the dust and put the computer back together. Sure enough, without the extra dust, the computer was quieter and quicker.

The extra dust in the vents was making the fans work harder, and louder. The extra dust on the central processing unit (CPU) and its fan was causing the CPU to quickly overheat, and it was running slower as a result. However, with all the dust gone, the computer was humming along quietly and returned to its previous speed.

It made me wonder how many people toss out perfectly good computers when all they need to do is clean them. I certainly understand how intimidating it can be for some users to open up a computer case and look inside. However, the A+ technician (you) with just a little bit of knowledge can be the hero for these people. You can help them restore their computer to its previous glory.

Computing Basics

At the most basic level, a computer has three functions: input, processing, and output. It accepts input, performs some processing, and provides an output, as shown in Figure 1-1. This is often shortened to just *input/output (I/O)*.

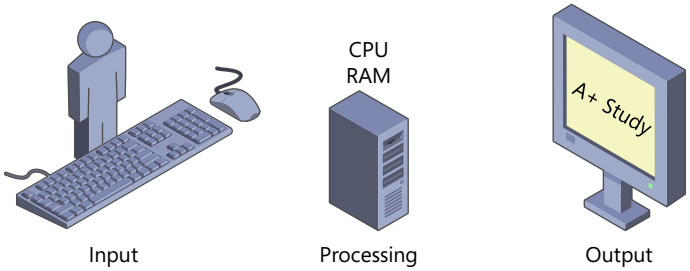

FIGURE 1-1 Input, processing, and output.

- **Input.** User-provided input comes from a keyboard, a mouse, or even a touch screen. Sometimes input is provided by other sources, such as a disk drive when opening files or a network interface card (NIC) when receiving data.
- **Processing.** The computer responds to the input by completing an action. The central processing unit (CPU) is the brain of the computer. It does the processing, and it uses random access memory (RAM) to store and manipulate data.
- **Output.** Output is commonly provided to a screen or a printer. However, computers also provide output to other destinations. These can include output to speakers or headphones to play sound, to disk drives when saving files, and to a NIC when transmitting data.

> ***NOTE*** **LONG-TERM AND SHORT-TERM STORAGE**
>
> **Computers are unable to work with data or programs until the information is in memory. Disk drives provide long-term storage, but information must be moved to the memory before the CPU can work with it. This is often transparent to the user.**

For example, imagine you wanted to open up a Microsoft Word document that has your A+ study notes. You would start by double-clicking the document, using the mouse as your input.

The computer processes your double-click with several actions:

1. It identifies the extension of the Microsoft Word file (.doc or .docx). It recognizes that this extension is associated with Microsoft Word.
2. It locates and retrieves the Microsoft Word program from the disk drive and begins moving the program from the disk drive to memory.

3. When the program is in memory, the computer can actually run it.
4. The computer begins sending results to the graphics card, showing the process of Microsoft Word starting.
5. When Microsoft Word is in memory and started, the computer locates the Word Study Notes file and moves it from the hard drive to memory.
6. When the file is in memory, the computer begins sending results to the graphics card.

NOTE **IPO**

Computer troubleshooting can often be reduced to identifying what is not working: input, processing, or output (IPO). When you identify this, it's much easier to troubleshoot and resolve the problem.

The preceding IPO process is constantly repeated. Consider typing your A+ notes about fans or power supplies into your study file. Each key press is another input that is processed and generates an output. The computer identifies what key you pressed, stores its value in memory, and displays it on the screen. When you save the file, it writes everything in its memory to the file on the drive.

Despite being able to do so much, it's worth pointing out that computers are pretty dumb. They can work only with numbers. Specifically, they can work only with ones and zeros. Everything that is written to a disk drive or to memory is a series of ones and zeros.

Admittedly, computers can work with these ones and zeros very quickly. Ask it to multiply two five-digit numbers, and a computer will do so in a flash. However, it must first translate any input you give it to a string of ones and zeros, process these strings, and then translate the result of ones and zeros into a usable display.

With this in mind, it's important for any A+ technician to have a rudimentary understanding of some basic numbering systems.

Numbering Systems

You and I count by using decimal numbers. We understand the meaning of the numbers 0 through 9. After you get up to 9, the next number is 10. This is also known as a numbering system with a base of ten, because there are ten digits in the numbering system.

If you see a number like 2,357, you know that its decimal parts are two thousand, three hundred, fifty, and seven. Table 1-1 shows the underlying math, which should make a lot of sense to you if you're familiar with decimal numbers.

TABLE 1-1 Decimal Values

	10^3	10^2	10^1	10^0
Decimal value	1000	100	10	1
Number	2	3	5	7
Calculated value	2,000	300	50	7

- The column on the far left is 10^3, or 10 cubed. The value of 10 x 10 x 10 is 1,000. The number 2,357 has 2 in this column, so it represents 2,000.
- The next column is 10^2, or 10 squared. The value of 10 x 10 is 100, and the number 2,357 has 3 in this column, so its value is 300.
- Any number raised to the one power is itself, so 10^1 is 10. The number 2,357 has 5 in this column, so its value is 50.
- Last, any number raised to the zero power is 1, so 10^0 is 1. The number 2,357 has 7 in this column, so its value is 7.

If you add 2,000 + 300 + 50 + 7, you get 2,357. When you see the number 2,357, you probably don't think of it this way, but you do recognize the value. For example, if I said I was going to give you your choice of $2,357 or $7,532, you'd easily recognize that the first choice is a little over $2 thousand and that the second choice is over $7 thousand. By reviewing what you know, it's easier to bridge that knowledge to something that might be new to you.

Base ten numbers aren't very efficient for computers. They result in a lot of wasted space. Because of this, computers use different numbering systems, such as *binary* and *hexadecimal*.

Binary

Binary numbers have a base of two. Instead of using numbers 0 through 9, they only use the numbers 0 and 1.

> ***NOTE*** **BINARY BIT**
>
> **In binary, a single digit is referred to as a bit. A bit can have a value of 1 or 0. When it is a 1, it is considered to be on, or true. When the bit is a 0, it's considered to be off, or false.**

Consider the binary number 1001. Table 1-2 shows how you can convert this number to a decimal value that has more meaning to you and me.

TABLE 1-2 Binary Values

	2^3	2^2	2^1	2^0
Decimal value	8	4	2	1
Binary number	1	0	0	1
Calculated value	8	0	0	1

- The column on the far left is 23, or 2 cubed. The value of 2 x 2 x 2 is 8. The number 1001 has 1 in this column, so it represents a calculated decimal value of 8.
- The second column is 2 squared. The value of 2 x 2 is 4, and the number 1001 has 0 in this column, so its value is 0.
- Any number raised to the one power is itself, so 21 is 2. The number 1001 has 0 in this column, so its value is 0.
- Last, any number raised to the zero power is 1, so 20 is 1. The number 1001 has 1 in this column, so its value is 1.

If you add 8 + 0 + 0 + 1, you get 9. Therefore, the binary number 1001 has a decimal value of 9.

Hexadecimal

Although binary and bits work well with computers, they aren't so easy for people to digest. If you need to tell someone to use the number 201, that's rather easy. But if you need to tell someone to use the binary equivalent, it's 1100 1001. That string of ones and zeros is a little difficult to communicate. However, you could also express the same number as C9 by using hexadecimal.

Hexadecimal uses the characters 0–9 and A–F, adding six extra digits to the base ten numbers of 0–9. Hexadecimal uses a base of 16. It is easier to express than binary and more efficient for computers than base 10 because it easily translates to binary.

NOTE **BINARY GROUPING**

When grouping several binary numbers, it's common to separate groups of four with a space. This is similar to adding commas to decimal numbers. For example, 135792468 is often expressed as 135,792,468 because the commas make it easier to see that it starts with 135 million. Similarly, 11001001 isn't as easy for most people to process as 1100 1001, although both numbers mean the same thing.

The binary number 1100 1001 can also be expressed as C9, because 1100 is C in hexadecimal and 1001 is 9 in hexadecimal. Table 1-3 shows the decimal, binary, and hexadecimal equivalent for the numbers up to hexadecimal F.

TABLE 1-3 Decimal, Binary, and Hexadecimal Values

Decimal	Binary	Hexadecimal	Decimal	Binary	Hexadecimal
0	0000	0	8	1000	8
1	0001	1	9	1001	9
2	0010	2	10	1010	A
3	0011	3	11	1011	B
4	0100	4	12	1100	C
5	0101	5	13	1101	D
6	0110	6	14	1110	E
7	0111	7	15	1111	F

NOTE **HEXADECIMAL CASE**

Hexadecimal numbers are not case sensitive. An uppercase C is the same as a lowercase c, and both equate to 1100 in binary. They are expressed both ways by different applications. Additionally, hexadecimal numbers are often preceded with 0x that to indicate that they are hexadecimal numbers. For example, if Windows 7 stops responding, the screen will display an error code such as STOP Error 0x0000002E, or hexadecimal code 2E. (This error code indicates a problem with memory.)

A common example of how hexadecimal numbers are used is with media access control (MAC) addresses. Network interface cards are assigned 48-bit MAC addresses, and these are commonly listed in six pairs of hexadecimal numbers like this: 6C-62-6D-BA-73-6C. Without hexadecimal, the MAC would be listed as a string of 48 bits.

Bits vs. Bytes

A single binary number is a *bit,* and eight bits makes up a *byte*. You can extend binary as far as you need to, but most computer technicians deal with numbers that do not go beyond a byte. This is not to say that computers can't work with more than eight bits. They certainly can. However, technicians and other Information Technology (IT) professionals still express the numbers as bytes.

Table 1-4 shows the value of each of the bits in a byte. The column on the far left is 2^7, or 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2. If you convert this to decimal, it is 128.

TABLE 1-4 Bits in a Byte

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

NOTE **IPV4 IS 32 BITS**

In networking, IPv4 addresses are 32 bits long. These addresses are commonly divided into four groups of eight bits, or four bytes. Additionally, the groups are usually expressed in decimal format. For example, an IPv4 address of 192.168.1.5 could also be expressed in binary as 1100 0000 . 1010 1000 . 0000 0001 . 0000 0101.

Kilo, Mega, Giga, and Tera

Computers handle huge numbers of bytes, which are often expressed as *kilobytes (KB)*, *megabytes (MB)*, *gigabytes (GB)*, and *terabytes (TB)*. A KB is 1,024 bytes, but most technicians shorten this to "about a thousand" bytes.

NOTE **ONE THOUSAND OR 1024**

You may be wondering why a KB is 1,024 bytes instead of one thousand bytes. Kilo literally means thousand, so you'd think that one KB would be one thousand bytes. However, the bytes are calculated by using binary with the formula of 2^{10} (or 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2). If you plug these numbers into a calculator, you'll see that it works out to 1,024.

Here's a comparison of these values:

- KB = about one thousand bytes (2^{10})
- MB = about one thousand KB or about a million bytes (2^{20})
- GB = about one thousand MB or about a billion bytes (2^{30})
- TB = about one thousand GB or about trillion bytes (2^{40})

Quick Check

1. **What is the decimal value of the hexadecimal character C?**
2. **How many bits are in a byte?**

Quick Check Answers

1. 12
2. 8

Cases and Cooling

Computer cases house many of the components in the computer, and there are many different types, sizes, and shapes of cases. Standard *personal computers (PCs)* use desktop cases. Some cases are towers that stand up beside a desk, and others fit on top of a desk. The common purpose of a computer case is to house the components needed within a computer.

Figure 1-2 shows an opened computer case with several components highlighted.

FIGURE 1-2 Computer case.

1. **Power supply.** The wires coming out of the right side of the power supply are connected to different computer components.
2. **CPU fan.** This is a dedicated fan to keep the CPU cool. The CPU is directly beneath this fan and can't be seen.

3. **Case fans.** This case has two fans, a smaller one on the left and a larger one on the bottom right. These fans pull air into the case. Vents on the case are positioned so that air constantly flows over key components to keep them cool.
4. **Motherboard.** The large white square outlines the motherboard. Multiple components are located on the motherboard, including the CPU, RAM, and the graphics card. Chapter 2, "Understanding Motherboards and BIOS," provides more details on the motherboard, and Chapter 3, "Understanding Processors and RAM," covers RAM. Chapter 6, "Exploring Video and Display Devices," covers displays and graphics (including graphics cards) in more detail.
5. **Optical drive bays.** CD and DVD optical drives are located here. This system has two drives, with space for another one.
6. **Hard disk drive bays.** Hard disk drives are used for permanent storage of data. This system has two hard disk drives, with space for another one. Chapter 4, "Comparing Storage Devices," covers the different types of storage devices.

You can also see a variety of different cables within the case. The power supply cables are covered later in this chapter, and other cables and connectors are covered in future chapters.

Not all cases have this much space or this many components. However, Figure 1-2 does give you an idea of what you'll see within a computer case.

A quick exercise you can do is to open your computer's case and peer inside. Make sure you first power the computer down and unplug the power cable. One side of the case can normally be opened by removing two thumb screws on the back of the case and pulling off the side panel. There's no need to manipulate anything inside the case at this stage, but you can look at it and compare your case with the case shown in Figure 1-2.

EXAM TIP

A+ exam questions often expect you to be able to identify components within a computer. Looking at different computers will help you correctly answer these questions. If you don't have multiple computers handy, check out the pictures on *bing.com*. Type in your search phrase (such as "computer case," "motherboard," or "power supply") and select Images.

Motherboards

As you can see in Figure 1-2, the motherboard takes up a significant amount of space. The case shown in the figure is relatively large, and you will likely see other computers where the case is not much larger than the length and width of the motherboard. All the components are squeezed in. These smaller cases don't have as much room for expansion, such as adding hard drives.

An important consideration related to the motherboard and the case is ensuring that the case can adequately house it. If you ever replace a computer's motherboard with a different brand or model, you'll need to ensure that it fits within the case.

Chapter 2 covers motherboard form factors in more depth, but as an introduction, the Advanced Technology Extended (ATX) motherboard form factor is the most common. The ATX standard has been in use since 1995, with several improvements and modifications added over the years. Many cases are designed so that they will support ATX motherboards.

Case Fans

Computers can get very hot, so fans are used to keep cool air flowing over the components. They draw air in from the room, direct it over key components, and then the air exits from vents on the case.

Fans come in different levels of quality, and the most noticeable difference is in how much noise they make. Inexpensive fans have cheap bearings that are noisy, while quality fans have sophisticated bearings that are extremely quiet. Many quality fans include a thermistor, which automatically adjusts the speed of the fan based on the temperature.

Common Problems with Fans

When a case fan becomes clogged or dirty, it can be so noisy that people commonly complain it sounds like a jet engine. They never get quite that loud, but they can be a nuisance.

Even worse, if the case fan is clogged, the computer is often not getting enough air flow through it. Internal components become hotter, and it's common for the entire system to slow to a crawl. In some cases, problems with the fan can cause the system to fail.

EXAM TIP

Intermittent failures, such as random restarts, are often an indication of a heat-related problem. This is especially true if the fans are loud, indicating that they are working very hard.

The easy solution is to clean the fan along with the case as described in the Cleaning Cases section later in this chapter. This will often reduce the noise and increase the performance. If it doesn't solve the problem, you can replace it with a higher-quality fan.

If a fan fails completely, it should be replaced as soon as possible to ensure that other components do not overheat and fail.

NOTE **CLOSE THE CASE**

In different situations, many technicians are tempted to run a computer with its case open. However, the vents on the case are strategically placed to ensure that air flows over specific components to keep them cool. If the case is left open, these components do not have enough air flow over them, which can cause them to overheat.

Replacing a Fan

A fan is considered a *field replaceable unit (FRU),* so if a fan is too noisy or has failed, you can replace it. Many companies sell case fans, and they are relatively easy to replace on a system. If you do replace the fan, make sure that the fan you're purchasing fits in your case. The two most common sizes for case fans are 80 mm and 120 mm.

Figure 1-3 shows the case fan within a system. Take a look at it as you follow the steps to remove the fan.

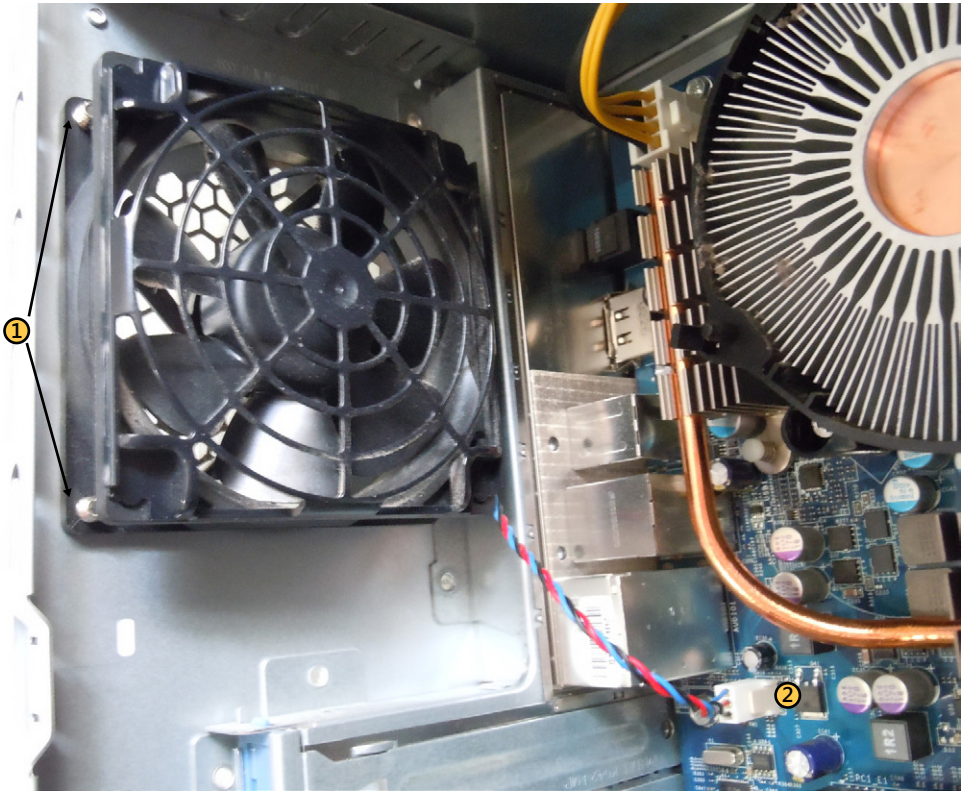

FIGURE 1-3 Removing a case fan.

IMPORTANT **TURN OFF THE POWER**

Ensure that the computer is turned off and that the power cable is removed before opening the case and replacing a fan. Power is still provided to the motherboard even if the system is turned off, and you can cause damage to the computer or yourself if the power cable is not removed.

1. **Remove four screws from the back of the case.** The arrows in Figure 1-3 point to two of the screws, and the other two screws are on the other two corners of the fan.
2. **Remove the power connector.** The power connector plugs into a specific jack on the motherboard. Take note of this jack, and ensure that you plug the new fan into the jack the same way. Fan connectors can use two, three, or four pins. The 4-pin connectors are commonly used with variable speed fans, allowing the computer to control the speed of the fan. You can also use adapters to connect some fans into a *Molex* type of connector from the motherboard.

After removing the old fan, you can install the new fan by reversing your steps. Attach the four screws and plug it in.

Even with new fans, though, if the case vents become clogged with contaminants, the fans will work harder to pull the air through the system. The easy solution is to clean the case.

Cleaning Cases

With all the air blowing into the computer case, it will gather some dust. In extreme work environments, the inside of a computer can get quite dirty. For example, a computer within a manufacturing plant will collect dirt and contaminants inside the case. Similarly, a computer with dogs or cats in the area can collect fur and hair.

It's relatively easy to clean a case. The most common method is by using a can of compressed air, which you can purchase from electronics stores. Take the computer outside, remove the cover, and use the compressed air to blow out the dust and other contaminants.

EXAM TIP

Cleaning a case and its fans can improve a computer's performance. Excessive dust creates additional heat, and many computers include components that can automatically sense the temperature. These components often increase the speed of the fans, making the system louder, and also slow down the speed of the CPU to reduce the heat.

Notification Switch for Security

Many computer cases have a special push-button switch that detects whether the case has been opened. This is also called a *biased switch,* and it stays depressed as long as the case is closed. When the case is opened, the switch opens and the change is recorded in the

computer. The next time the system starts, it indicates that the system case has been opened. This is useful for detecting whether someone has been tampering with a computer.

Quick Check

1. What are the two common sizes of a case fan?
2. A computer has become louder and slower. What is a common solution?

Quick Check Answers

1. 80 mm and 120 mm.
2. Clean it.

Power Supplies

Computers run on electricity. Electricity is measured as voltage, and voltage is the difference in potential between two points. For example, an electrical signal can be 12 volts above a ground potential of zero volts, giving it a value of 12 volts. Power supplies within computers ensure that components within a system consistently have the correct voltages.

As an A+ technician, you might need to troubleshoot a system with a faulty power supply or even replace a power supply. With that in mind, you need to have a basic understanding of power supplies.

AC vs. DC

The two types of voltages are alternating current (AC) and direct current (DC). *AC voltage* alternates above and below zero volts, and *DC voltage* provides a steady voltage either above or below zero.

Commercial power companies traditionally provide power as AC, which looks like a sine wave. Power supplies within computers convert this AC voltage into DC voltage, as shown in Figure 1-4.

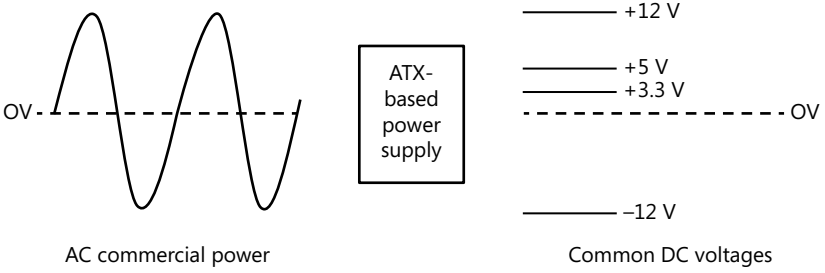

FIGURE 1-4 AC vs. DC.

Figure 1-4 isn't to scale. AC voltages vary about 115 VAC (volts AC power) above and below 0 volts in many regions, such as in the United States, and 230 VAC above and below 0 volts in other regions, such as in Europe. The key point is that AC voltage is an alternating or varying voltage, whereas DC voltage is a constant steady voltage. The DC voltages shown in the figure are common voltages used within computers, and are sometimes expressed as VDC, such as 12 VDC.

Wattage Power Ratings

Power supplies are rated based on the amount of power they can provide, and power is computed as a *watt (W)*. In simple terms, watts are computed by multiplying the voltage by the amperage. Amperage (A) refers to the rate of flow of the voltage. Higher amperage results in a higher rate of flow, and higher amperage with the same voltage provides more power.

Each individual component within a computer requires a certain amount of power. For example, it's not uncommon for a CPU to require as much as 100 W. Additionally, the motherboard, case fans, and disk drives all draw additional power. With this in mind, power supplies must not only convert AC to DC and supply the correct DC voltages, but they must also provide enough power to support all the components in the system.

When replacing a *power supply unit (PSU),* you should look for the W within the specifications to identify the power output. For example, a 600-watt PSU would be listed as 600 W. The range of common current ATX-based PSUs is about 300 W to 1,000 W.

If a system requires 600 W and you put in a 300-W power supply, you'll have some problems. In most cases, the computer simply won't work. In other cases, the power supply won't be able to provide steady voltages and the variances might damage system components.

Rails

Power supplies provide separate lines (called *rails*) for the different voltages. The voltage that draws the most power is 12 V, used for CPUs, case fans, and disk drives, and a single 12-V rail provides 18 A of power. However, this single 18-A rail often isn't enough to power all the components that need the voltage.

Many current power supplies include at least two 12-V rails, with one rail dedicated to the CPU and the second rail dedicated to everything else. Some power supplies include three or four rails. When replacing a power supply, you need to ensure that you are replacing it with one that has at least the same number of 12-V rails as the original.

EXAM TIP

The 12-V rails provide primary power to disk drives. If these rails are overworked, they will frequently cause problems for the hard drives. In other words, if hard drives are frequently failing in a computer, consider replacing the power supply with one that has an additional 12-V rail.

Power Supply Connections

The ATX standard mentioned within the Motherboards section earlier in this chapter also identifies power supply requirements. Most current desktop systems include power supplies that support ATX-based motherboards, and they provide specific voltages defined in the ATX specifications.

Figure 1-5 shows the rear view of a power supply, along with its connectors. This power supply was removed from a computer with an ATX-style motherboard. Refer to the figure as you read the following descriptions.

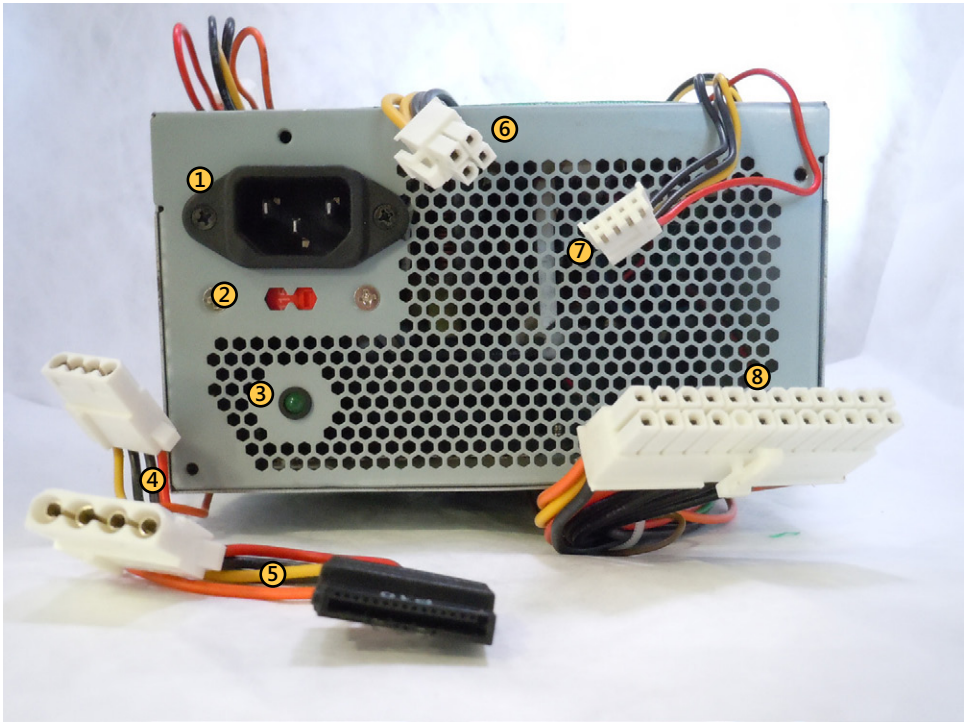

FIGURE 1-5 Power supply.

1. **AC power jack.** The power cable connects from here to a power source providing AC power.
2. **Dual voltage power selection.** Select 115 or 230 based on the commercial power provided at your location. For comparison, commercial power provided in the United States is 115 VAC, and power provided in Europe is 230 VAC. Some systems can automatically sense the voltage, so the switch isn't needed.

EXAM TIP

If you have this selection set at 230 and you plug it into a commercial power source providing 115 VAC, it won't have enough power to run the computer. On the other hand, if you set it to 115 and you plug it into a 230-VAC power source, you will likely destroy the power supply. If you hear pops, smell burning components, or smell smoke, unplug it as quickly as possible and check this switch.

3. **Power indicator.** When on, it indicates that the power supply has power. This does not indicate that the actual computer is turned on. Computers typically have a separate power button and power indicator on the front of the case.
4. **Molex connectors.** These provide 5 V and 12 V to different devices, such as Parallel Advanced Technology Attachment (PATA) disk drives.
5. **SATA power connector.** This 15-pin connector provides power to Serial Advanced Technology Attachment (SATA) disk drives. It includes 3.3-V, 5-V, and 12-V DC voltages.
6. **Secondary motherboard power connection.** Most current motherboards use a 4-pin connector that provides 12 VDC used by the CPU. This connector is formally called ATX12V but is also known as P4 because it was first used with the Pentium 4 CPUs. Systems with more than one CPU use an 8-pin connector (or two 4-pin connectors) to provide power for multiple CPUs. This is formally known as EPS12V.
7. **Floppy drive mini-connectors.** These are sometimes called Berg connectors or mini-Molex connectors. They provide 5-VDC and 12-VDC power to 3.5-inch floppy drives, when the system includes floppy drives.
8. **Primary power connector.** A 20-pin or 24-pin connector provides primary power to the motherboard. It's commonly called the P1 connector and provides 3.3 VDC, 5 VDC, and 12 VDC to the motherboard.

EXAM TIP

You might need to troubleshoot a power supply and verify that it is supplying the correct voltages. With this in mind, you should be aware of valid voltages on the different connectors. Black wires are ground (or a zero potential), orange wires carry 3.3 V, red wires carry 5 V, yellow wires carry 12 V, and blue wires carry -12 V.

Many power supplies also have a PCI Express (PCIe) power connector. This was originally a 6-pin connector, but new systems use an 8-pin connector similar to the one shown in Figure 1-6. Some power supplies use a 6+2 connector, allowing you to plug it into an older system with only 6 pins, or a newer system with 8 pins.

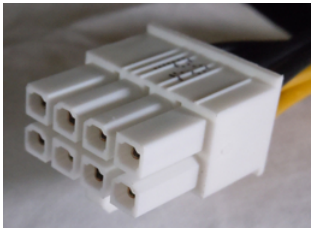

FIGURE 1-6 PCIe power connector.

Cable Keying

Most cables are keyed. That is, they are designed to fit into a jack in one way, and one way only. However, these connectors and plugs are just plastic, so it is possible to force a connector onto a plug backwards. If you do, the wrong voltages or signals will be sent to a device.

In the worst case scenario, plugging a cable in backwards can destroy a device. If you're lucky, plugging the cable in wrong will just result in the device not working. Neither result is desirable, so it's best to look for the key and ensure that you plug in the connector correctly.

Figure 1-7 shows some common methods of how cables are keyed.

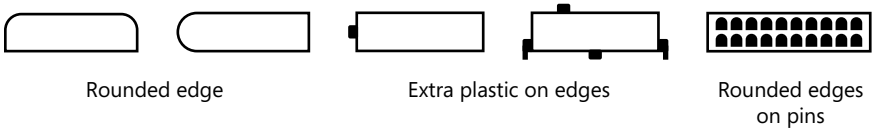

FIGURE 1-7 Cable keying examples.

It might not be apparent in Figure 1-5 shown earlier, but several of the connectors have keyed connectors similar to that shown in Figure 1-7. The Molex connectors (item 4 in Figure 1-5) have rounded edges. The SATA power connector (item 5) has an extra edge. The mini-connector (item 7) has several extra edges. The primary power connector (item 8) has rounded edges on the individual pins.

IMPORTANT **NEVER FORCE A CONNECTOR**

Plugging in any connector the wrong way can damage the computer. Although the keying does help, the connectors are plastic and in some cases it is possible to force a connector onto a plug the wrong way. If a connector doesn't seem to fit, don't try to force it. Instead, double-check the keying to ensure that it is plugged in correctly.

ATX vs. Micro-ATX Power Supplies

ATX power supplies are the standard used in many computers today. However, some smaller PCs have lower power requirements and can be powered by using smaller power supplies. Micro-ATX power supplies provide a lower amount of wattage, often between 180 and 300 watts, though some special-purpose power supplies are as low 90 watts.

The micro-ATX power supplies are smaller in size and have fewer power connectors than a regular ATX-based power supply. Also, the primary power connector (P1) usually has only 20 pins on the micro-ATX power supply, rather than the 24 pins often found on ATX-based power supplies.

Replacing a Power Supply

Many components within a computer, including the power supply, are modular. When a module fails, you need to replace only the module, not the entire computer. This is similar to a car. If your car gets a flat tire, you replace the tire, not the entire car. If the power supply fails in a computer, you replace the power supply.

EXAM TIP

When power supplies fail, you can sometimes see smoke or smell burning components. New power supplies often give off an odor for a short burn-in period, but they aren't faulty. However, if you see smoke or hear sparks, remove power immediately.

The primary indicator that the power supply has failed is that the system doesn't have any lights or indicators. Of course, you'd want to verify that the computer is plugged in and turned on. Also, some systems have a power switch on the power supply that needs to be turned on in addition to turning on the power via a switch or button in the front of the system. If you've checked these but still have no power indications, it might be time to replace the power supply.

The power supply is relatively easy to replace, but you need to keep a few important concepts in mind:

- **Turn off and remove the power plug.** You should not attempt to replace computer components while the system is plugged in. The exception is "hot swappable" components such as USB flash drives that are designed to be inserted or removed while turned on.
- **Use a suitable replacement.** Ensure that the wattage of the replacement is at least as high as the original, if not higher. Also, ensure that the power supply has at least the same number of 12-V rails as, if not more, than the original.
- **Document cable placement.** Pay attention to the cables before you take them out. Draw a diagram showing where each cable goes, or take a couple of pictures with your cell phone. Without this documentation, when the old power supply is out

and the new power supply is in, you might have trouble remembering where all the cables went. Also, ensure that you identify the keying of the cables and plug them in correctly.

When you're ready to replace the power supply, you'll find there are only four screws holding it on. Remove the cables and the screws, and you'll be able to remove the power supply. Occasionally, you might need to remove other components first to get to the power supply and remove it.

Protecting Systems from Power Problems

Commercial power isn't always stable, and it can sometimes cause problems to computers. However, there are some basic steps you can take to protect them. Some of the common problems you might see on commercial power lines are as follows:

- **Surge.** Commercial power can occasionally increase or *surge*. Instead of providing a steady 115 VAC, it can increase to 120 VAC or higher. Surges are usually short term and temporary but can sometimes be observed as lights become brighter.
- **Spike.** This is a quick, sharp increase in AC voltage. The voltage immediately returns to normal, but the *spike* can destroy unprotected equipment. Lightning strikes are a common source of spikes.
- **Sags and brownouts.** Commercial power can also reduce or *sag*. Instead of providing a steady 115 VAC, it can decrease to 110 VAC or lower. If this occurs for less than a second, it's called a sag, but if it lasts longer, it's referred to as a *brownout*. You can often see lights flicker or become dimmer during brownouts, and they can cause systems to restart.
- **Blackouts.** A *blackout* is the total loss of power (or the reduction of power to such a low level that the equipment is unable to operate). The following sections identify some of methods used to protect against power-related problems.

Surge Suppressors

A *surge suppressor* is a power strip with extra protection. It has built-in sensors that can detect when the power surges or spikes. Most surge suppressors have a circuit breaker that will pop when it detects surges or spikes. When the circuit breaker pops, the surge suppressor no longer provides voltage to any systems plugged into it. You can usually reset it by pressing a button on the surge suppressor or by turning it off and back on.

> ***NOTE*** **POWER STRIPS VS. SURGE SUPPRESSORS**
>
> **A power strip is similar to an extension cord with extra power plugs. Many people assume it protects against surges and spikes, but it does not provide any protection. Surge suppressors include some type of tag or marking indicating that they are surge suppressors.**

Battery Backup

An *uninterruptible power supply (UPS)* provides the benefits of a surge suppressor and also provides constant power to a system. It includes batteries, and if commercial power is lost or sags, it can continue to supply power to systems for a short time, for as much as 10 or 15 minutes or longer.

For example, I recently added an UPS rated at 900 watts. I plugged in my primary PC and flat screen monitor, but nothing else, to the UPS. During a power outage, the UPS continued to provide power for over an hour. If I had two PCs and two monitors plugged into it, the UPS would likely have lasted only about 30 minutes.

If power isn't restored within a certain time frame, the UPS can send a signal to the computer to perform a logical shutdown. This prevents hardware and software problems caused by unexpected power losses.

Figure 1-8 shows how the UPS is connected to the computer. The UPS plugs into the wall to receive commercial power. This power provides a continuous charge to the batteries within the UPS. The UPS provides AC power to the computer or to other systems plugged into it. If power fails, the UPS continues to provide power to the computer for a short time.

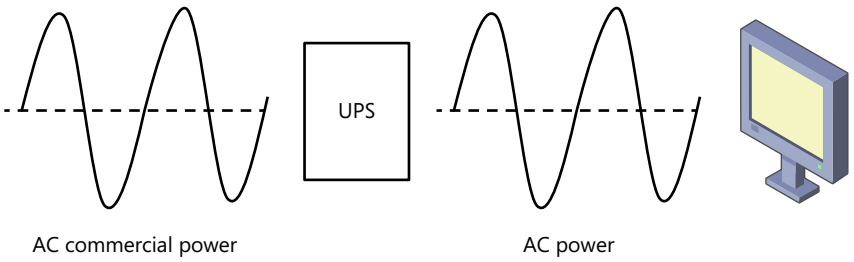

FIGURE 1-8 UPS used to protect against short-term power loss.

EXAM TIP

An UPS can be used to provide power to computers for short-term power. Laser printers draw a significant amount of power, and they should not be plugged into an UPS.

It's important to ensure the UPS system can meet the power requirements of the systems you're trying to protect from power outages. Additionally, you should plug in only systems that you need to keep operational during short-term power failures. If you plug all your equipment into the UPS, they will draw additional power. This will reduce the amount of time that the UPS provides power to these systems during an outage. Other equipment should be plugged into a surge suppressor.

Quick Check

1. What voltages are provided by an ATX power supply?
2. What should you check if you have hard drives frequently failing?

Quick Check Answers

1. 3.3 V, 5 V, 12 V, and -12 V
2. 12-V rails

Safety Issues

When working on computers, it's important to pay attention to safety considerations. A basic premise to always keep in mind is that computers are just things that can be replaced, but we can't replace people. In other words, value people first when working with computers. By following basic safety precautions, you can prevent damage to people and to equipment.

Electrical Safety

Unless you're measuring voltages within a computer, you should never work on computers without first removing power. This includes turning the computer off and unplugging it.

Just turning off the power is not enough. ATX-based power supplies provide power to the motherboard even if the front power switch on the computer indicates that it is turned off. If you want to ensure that the computer does not have any power, unplug the power supply.

Most people consider PSUs modular units. In other words, if the PSU fails you simply replace it instead of trying to repair it. However, if you do open the power supply, don't forget the following two important warnings:

- Never open it when it is plugged in.
- Even after you unplug it, capacitors within the power supply will hold a charge. If you touch the capacitor, it can easily discharge and shock you. I learned this lesson firsthand when playing with one of my father's radio sets when I was about eight years old. It knocked me against the wall and left my mother white-faced for quite a while.

Equipment and Self-Grounding

In electronics, *ground* refers to a path to Earth. A copper cable is attached to a spike and hammered into the ground. The other end of this cable is available in the electrical system and identified as a ground. Most electrical equipment includes circuitry that will automatically redirect any dangerous voltages to ground to prevent shocks.

IMPORTANT **EQUIPMENT GROUND CONNECTIONS SHOULD ALWAYS BE CONNECTED**

Disconnecting ground connections can bypass safety circuits. Dangerous voltages can be redirected to the computer case, resulting in a shock if a user touches the case.

Ground is referred to differently based on the location of the connection. For example, Figure 1-9 shows the three primary symbols used for ground.

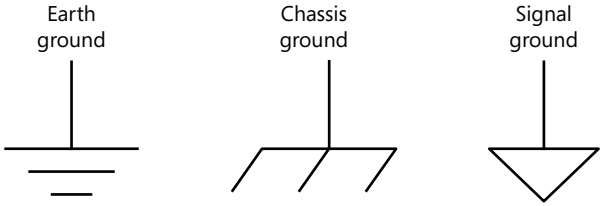

FIGURE 1-9 Ground symbols.

Earth ground is the path directly to Earth. *Chassis ground* refers to the path to the equipment case or chassis. *Signal ground* refers to the return path for a signal. Signal ground connections are commonly connected to the chassis. For example, some screws connecting a motherboard to a computer case connect the motherboard signal ground to the case. The chassis ground is then connected to the Earth ground via the power cable.

ESD

Static electricity builds up on different types of objects, and when one object touches another, the static discharges. You've probably experienced a static discharge after walking across a carpeted floor and touching a doorknob. This is also called *electrostatic discharge (ESD)*.

The shock you felt might have been unpleasant, but it wasn't harmful. However, it can be damaging to computers. If you felt it, at least 3,000 volts were discharged from your hand to the doorknob. If you actually saw the spark when it discharged, it was at least 8,000 volts. The good news is these voltages won't kill or hurt people, mostly because they aren't combined with current to generate power.

In contrast, computer components can be damaged by as little as 250 volts. You won't see it. You won't feel it. However, the damage will be real.

The primary way to prevent ESD damage is by ensuring that the worker and the equipment are at the same ground potential. Steps you can take to reduce ESD damage include the following:

- **Use an ESD wrist strap.** An ESD wrist strap wraps around your wrist and has a metal component touching your skin. A wire leads from the strap to an alligator clip that you can clip to the computer case. This results in you and the case being at the same potential, and it prevents static discharge. On work benches, ESD straps are used to

connect the equipment case to a grounding bar that is connected to Earth ground. The technician can connect alligator clips from the wrist strap to the case or to the grounding bar.

- **Use antistatic bags.** When storing and transporting electronic components, they should be stored in antistatic bags. These bags help prevent static from building up and causing ESD damage to the components.
- **Use ESD mats.** Special ESD mats prevent static buildup, and they are commonly used on work benches. Technicians place computers on the antistatic mat while working on them. Larger antistatic mats can be placed on the floor in front of the technician's bench to reduce static.

EXAM TIP

Very small amounts of ESD can cause damage. This is especially true when handling sensitive components such as CPUs and memory. ESD protection such as antistatic wrist straps, antistatic component bags, and antistatic mats are valuable to protect against ESD damage when handling CPUs, memory, and other sensitive components.

- **Self-grounding.** If you touch the computer case before working on any components, built-up static will discharge harmlessly onto the case. This ensures that your body is at the same ground potential as the case. Additionally, if you keep your feet stationary after touching the case, it reduces the chances for static to build up.
- **Don't touch components or pins.** If you remove any circuit cards, don't touch the components or the pins. Instead, hold the outside edges or the plastic handles.
- **Control humidity.** When the humidity is very low, static builds up more quickly. If you live in a colder area, you'll notice that static is more common in the winter because heating systems remove humidity from the air. In contrast, when the humidity is higher, the static charges dissipate naturally. Ideally, humidity should be around 50 percent.
- **Don't place computers on carpets.** Static can build up on carpets more easily than on other floor surfaces. You've probably noticed that in a heated building you can shuffle your feet over a carpet to quickly build up static. This doesn't work on tile floors or other floor surfaces.

MSDS

Material Safety Data Sheets (MSDSs) are available for most products that have a potential to cause harm to people or equipment. This includes materials such as cleaning solutions, paints, and chemicals. The MSDS identifies important safety facts about the material including its contents, its characteristics, how to handle and store it safely, and how to dispose of it. It will also list first-aid steps to take if the material presents a danger.

As an A+ technician, you are likely to use products that have MSDS sheets. For example, you might use cleaning products that clean computer screens or keyboards. If any of these products is causing an adverse reaction to either people or the equipment, you can refer to the MSDS sheet for information about the product and additional steps to take after the exposure.

Compliance with Regulations

Any government regulations pertaining to safety or environmental controls must be followed. For example, the state of California has mandated that all batteries be disposed of as hazardous waste. Even if the batteries are the newer mercury-free alkaline batteries, the regulation still requires special handling.

> ***NOTE*** **IGNORANCE IS NO EXCUSE**
>
> **An old saying related to the law is that "ignorance is no excuse." With that in mind, organizations have a responsibility to learn what regulations apply to them where they operate, and to comply with those regulations.**

Fire Safety

Fires are classified based on what is burning, and fire extinguishers are classified based on what fires they can safely extinguish. The four primary types of fires are as follows:

- **Class A.** This type of fire involves ordinary combustible material such as paper and wood. The fire can be extinguished with water or a Class A fire extinguisher.
- **Class B.** This type of fire involves flammable liquids and gases. Class B fire extinguishers use chemicals to disrupt the chemical reaction, or they smother the fire with a gas such as carbon dioxide. Spraying water on a Class B fire is dangerous because it will spread the fire instead of extinguishing it.
- **Class C.** An electrical fire is a Class C fire, and the best way to extinguish it is by removing the power source. For example, unplugging it or turning off the circuit breaker can stop the fire. Class C fire extinguishers use special chemicals such as Purple-K or carbon dioxide to extinguish a fire.

> ***IMPORTANT*** **NEVER USE WATER TO EXTINGUISH CLASS C FIRES**
>
> **Water is conductive. Electricity can travel up the water stream and electrocute you if you spray water onto an electrical fire.**

- **Class D.** This type of fire involves combustible metals. A Class D fire extinguisher uses special chemicals to smother the fire. Water should not be used.

Lifting

When lifting equipment, it's best to lift with your legs, not your back. In other words, instead of bending down to pick up heavy equipment, you should squat, bending your knees, to pick it up.

There aren't any firm guidelines on safe weight limitations. However, it's generally recommended that individuals do not try to lift equipment weighing more than 70 pounds without help.

Quick Check

1. What can be used to protect against ESD?
2. What includes first-aid steps to take if cleaning supplies cause harm to a person?

Quick Check Answers

1. Controlled humidity, antistatic wrist straps, and antistatic mats
2. MSDS sheets

Tools

If you're going to work on computers, you'll need some tools. The following sections identify some common tools you should have.

Screwdrivers

Case fans, power supplies, and motherboards are all secured with screws, so if you need to remove them, you'll need a screwdriver. Most screws are Philips, so you'll need one or two Philips screwdrivers in addition to one or two flat-blade screwdrivers in your toolkit.

Extension Magnet

It's not uncommon to drop a screw within a system, but your fingers often won't fit into the small spaces to retrieve it. You can retrieve it with an extension magnet. An extension magnet has a handle similar to a screwdriver, but it has an extendable wand with a magnet on the end. In some situations, the screw might fall onto other electrical components, such as the motherboard. Instead of using the extension magnet, you can use a pair of plastic tweezers to avoid possible damage to system components.

Compressed Air and Compressors

As mentioned previously, compressed air can be used to clean out a computer case. You can purchase cans of compressed air online or at computer and electronics stores. They usually have plastic straws that you can attach to the spray nozzle so that you can direct the air into the nooks and crannies of the case. Compressed air is also useful for blowing out keyboards, printers, and laptop cases.

Compressors are electronic motors that build up air pressure and allow you to blow out components with a hose. For example, many gas stations have compressors that you can use to add air to your tires. Unlike compressed air cans, a compressor will never run out of air.

IMPORTANT **BE CAREFUL WHEN USING AIR COMPRESSORS**

Some compressors have very high air pressure, which can damage components within the computer if you're not careful. Additionally, some air compressors collect water that can spray into the computer. Technicians that use these often have a regulator that they use to keep the pressure below 20 pounds per square inch (psi), and they use filters to trap any water. Some technicians strongly oppose using air compressors at all.

Computer Vacuum

In some cases, it isn't feasible to take computers outside to blow out the dust. However, if you blow out the dust inside the building, you're going to make quite a mess. Instead, you can use a computer vacuum cleaner to clean out the computer.

You should use only vacuum cleaners designed for the job. Regular vacuum cleaners generate static electricity and can easily damage the sensitive components within the computer. Computer vacuums are made of special materials and often use batteries instead of AC power.

EXAM TIP

Regular vacuum cleaners and their attachments can cause ESD damage to systems. Computer vacuums are made of special material resistant to ESD.

Multimeter

Multimeters have multiple functions, and technicians commonly use them to measure power supply voltages.

For example, power supplies sometimes lose the ability to provide constant power. Instead of a steady 12 V, a power supply might waver between 10 V and 14 V. Even though a system has some tolerance for variations, generally anything beyond 5 percent can cause problems, such as random restarts. Therefore, the 12-V line should not waver more than plus or

minus 0.6 V (11.2 V to 12.6 V). If you're experiencing random problems and suspect the power supply, you can use a multimeter to measure the voltages.

EXAM TIP

Random restarts can also indicate other problems. Overheating and in some cases faulty memory can cause a system to occasionally restart. Additionally, malicious software such as a virus can cause a system to randomly restart. Using a multimeter to verify that the voltages are stable can eliminate the power supply as a problem source.

Figure 1-10 shows a multimeter set to the V setting. It can measure both DC and AC voltages by using this setting. Additionally, this is an autorange digital multimeter (DMM), meaning that it can automatically sense the voltage range.

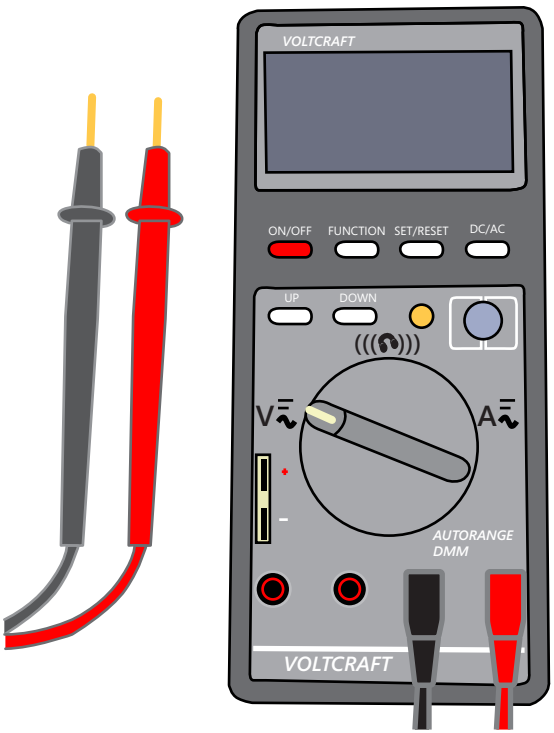

FIGURE 1-10 Digital multimeter.

Less expensive multimeters require you to set the range at the highest possible voltage to avoid damage. If you set it at a low voltage, such as 5 V, and then measure 12 V, you might damage the meter.

In Figure 1-10, you can see that the multimeter has two probes. It might not be apparent in the black-and-white picture, but one probe is red and one is black. You would connect the

black probe to a ground pin of a connector (with a black wire) and connect the red probe to the voltage pin in the connector. For example, if you want to measure 12 V provided on a connector, connect it to the pin with the yellow wire. If you want to measure the 5-V line, connect the red probe to the pin with the red wire.

CAUTION **SEVERE ELECTRICAL SHOCK POSSIBLE**

You can measure the voltage only when the power is on and supplying voltage to the system. Because of this you can be exposed to voltages when taking measurements. You should ensure that you do not touch anything within the computer except the connector. This includes touching components with your hands or with the multimeter probes.

When taking voltage measurements, you should remove jewelry. If the jewelry touches a metal component that has voltage, it's possible to short it out and damage the equipment. It could also shock you.

Multimeters can also take other measurements. Besides voltage, the most common measurement is a continuity check. When the meter is set to do a continuity check, you can touch the probes together and the meter will beep, indicating a continuous connection. You can use this setting to check for a break in a cable. You touch one probe to the connector on one side of a cable, and the other probe to the other side. If it beeps, it indicates a continuous connection in the cable, indicating that the cable is good. If it doesn't beep, the cable has a break and should be replaced.

Power Supply Tester

Most power supplies will not provide voltages unless they are plugged into the component. For example, if you want to measure voltages on the motherboard P1 connector, the P1 connector needs to be plugged in. If it's not plugged in, the voltages are zero.

This can be a problem if you want to check a power supply but you don't have a motherboard or other components. However, a *power supply tester* simulates the load for a power supply and lets you know if you have a problem. You plug the power supply cables into the power supply tester and turn it on. The tester will display the voltages, and if any of the voltages are outside specifications, it will indicate the problem.

Quick Check

1. **What should you use to clean out a computer case?**
2. **What can you use to verify a power supply is providing 12 VDC to a system?**

Quick Check Answers

1. **Compressed air, or a computer vacuum that doesn't generate static electricity**
2. **Multimeter**

Chapter Summary

- The three functions of a computer are input, processing, and output. These are often shortened to I/O.
- Binary numbers use only ones and zeros. Hexadecimal numbers are created from four binary bits and include the characters 0–9 and A–F. Eight bits make up a byte.
- Large numbers of bytes are expressed as KB, MB, GB, and TB.
- Computer cases house key computer components, including motherboards, case fans, and power supplies.
- Case fans help keep a system cool by drawing air into the case. Cases and fans often get dirty. They can become quite loud, and the system can slow down or intermittently fail. The easy solution is to clean them.
- Case fans can be replaced. If a fan fails, the system can overheat, so the fan should be replaced as soon as possible.
- Power supplies convert commercial AC power to DC voltages. Power supplies are rated based on the power they provide, expressed as watts (W). Replacement power supplies need to meet or exceed the power requirements of the computer.
- Dual voltage power supplies have a switch identified as 115 or 230 to identify the source voltage. Ensure that it is set to the correct voltage supplied by commercial power.
- ATX-based power supplies provide 3.3 V, 5 V, 12 V, and -12 V to system components through various power connectors. These voltages can be measured with a multimeter or a power supply tester.
- The P1 power plug is the primary power connector for the motherboard and includes 20 or 24 pins. Many systems have a secondary power plug that includes 4, 6, or 8 pins.
- Molex connectors provide 5 V and 12 V to PATA disk drives. The SATA connector provides 3.3 V, 5 V, and 12 V to SATA disk drives. Power to disk drives is provided via 12-V rails, and desktop power supplies commonly have two rails but can have more. If disk drives are failing, you might need a power supply with an additional rail.
- PCIe connectors use 6 pins, 8 pins, or 6+2 pins.

- Surge suppressors protect components against spikes and surges in power. UPS systems protect systems against sags and short-term power losses.
- ESD damage can be prevented by using ESD wrist straps and ESD mats, and by controlling the humidity.
- Extension magnets can help retrieve screws that can't normally be reached. Compressed air or special antistatic vacuum cleaners can be used to clean computers.
- MSDS sheets document characteristics about potentially hazardous material used in a work center, including how to store and dispose of hazardous material. When local regulations exist, they take precedence.
- Electrical fires are Class C fires. You should never use water on an electrical fire.
- Compressed air is the preferred method of cleaning systems. If a vacuum is used, it should be a special antistatic vacuum.
- Multimeters measure voltages and can check cable continuity. Power supply testers can check voltages on power supplies without a motherboard.

Chapter Review

Use the following questions to test your knowledge of the information in this chapter. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. A computer is making a lot of noise. Of the following choices, what is the likely problem?
   - **A.** Faulty motherboard
   - **B.** USB flash drive
   - **C.** Power supply set to wrong voltage
   - **D.** Case fan
2. Another technician ordered a fan for a computer case. It has arrived, and you need to install it. The original fan has been removed. Where should you connect the fan power connection?
   - **A.** AC outlet
   - **B.** P1 power supply connector
   - **C.** Front panel power
   - **D.** Motherboard

3. A power supply failed after a technician added some hard drives to a desktop computer. You need to purchase an additional power supply. What is a likely power rating you'll purchase to ensure that the power supply doesn't fail again?

   A. 600 W

   B. 600 V

   C. 300 W

   D. 250 V

4. Which of the following voltages are not provided by ATX-based power supplies? (Choose two.)

   A. 12 VDC

   B. -12 VDC

   C. 115 VAC

   D. 15 VDC

5. Molex connectors provide power to disk drives from ATX-rated power supplies. What voltages are supplied through the Molex connector?

   A. 3.3 V and 5 V

   B. 5 V and 12 V

   C. 5 V and 15 V

   D. 12 V and 15 V

6. A system is no longer booting to the SATA hard drive, and you suspect that the ATX-based power supply might not be providing the correct voltages. What voltages should you see on the SATA power connector?

   A. 3.3 VDC, 5 VDC, and 12 VDC

   B. 3.3 VDC, 12 VDC, and 15 VDC

   C. 5 VDC, 12 VDC, and 15 VDC

   D. 12 VDC, 15 VDC, and 24 VDC

7. Which of the following can you use to protect against power sags?

   A. Commercial power

   B. Power supply

   C. UPS

   D. MSDS

8. Which of the following can protect against ESD damage? (Choose all that apply.)
   - **A.** ESD wrist strap
   - **B.** Reducing humidity as much as possible
   - **C.** Ensuring that computers are stored on carpets whenever possible
   - **D.** ESD mat

9. You want to verify that a power supply is providing proper voltages while it's connected to the P1 connector on the motherboard. What would you use?
   - **A.** Surge suppressor
   - **B.** Multimeter
   - **C.** Power strip
   - **D.** Power supply tester

10. You open a computer to troubleshoot it and notice an excessive amount of dust inside it. Of the following choices, what is the best choice to clean it?
   - **A.** Lint-free cloth
   - **B.** Vacuum cleaner
   - **C.** Glass cleaner
   - **D.** Compressed air

11. Which of the following can contribute to ESD damage?
   - **A.** Case fans
   - **B.** Carpet
   - **C.** Touching the computer case while working on a computer
   - **D.** ESD mats

12. After cleaning a computer screen with a cleaning compound, your fingers start to develop a rash. What can you use to quickly identify what was in the cleaning compound?
   - **A.** MSDS
   - **B.** Internet
   - **C.** Local hospital
   - **D.** Coworkers

Answers

This section contains the answers to the chapter review questions in this chapter.

1. **Correct Answer:** D
   - **A. Incorrect:** When motherboards fail, they are not noisy.
   - **B. Incorrect:** Hard disk drives sometimes make a lot of noise when they are failing, but not USB flash drives.
   - **C. Incorrect:** If the power supply is set to the wrong voltage, it might make a single loud pop when it fails, or not work at all, but it won't make a lot of noise.
   - **D. Correct:** When case fans begin to fail, they are often noisy. They can also be noisy if they are dirty.
2. **Correct Answer:** D
   - **A. Incorrect:** Case fans do not get power from AC outlets.
   - **B. Incorrect:** The P1 connector provides power to the motherboard, not to fans.
   - **C. Incorrect:** Front panels do not have power for fans.
   - **D. Correct:** Fans get power from a connector on the motherboard.
3. **Correct Answer:** A
   - **A. Correct:** A 600-W power supply is common in desktop computers and is the best choice of those given.
   - **B. Incorrect:** Power supplies are rated in watts, not volts.
   - **C. Incorrect:** A 300-W power supply is on the low range found with desktop computers. If the original failed after adding an additional load with disk drives, a larger power supply is needed.
   - **D. Incorrect:** Power supplies are rated in watts, not volts.
4. **Correct Answers:** C, D
   - **A. Incorrect:** ATX-based power supplies provide 12 VDC.
   - **B. Incorrect:** ATX-based power supplies provide -12 VDC. They also provide 5 VDC and 3.3 VDC.
   - **C. Correct:** ATX-based power supplies use AC voltage as an input but do not provide AC voltage.
   - **D. Correct:** ATX-based power supplies do not provide 15 VDC.

5. **Correct Answer:** B

   A. **Incorrect:** 3.3 V is provided to the motherboard through the 20-pin or 24-pin P1 connector, but not on the Molex connector.

   B. **Correct:** Molex connectors supply 5 V and 12 V from the power supply to different drives in a computer.

   C. **Incorrect:** 5 V is provided through both Molex and the P1 motherboard connector, but 15 V is not used in ATX power supplies.

   D. **Incorrect:** 12 V is provided through both Molex and the P1 motherboard connector, but 15 V is not used in ATX power supplies.

6. **Correct Answer:** A

   A. **Correct:** The correct voltages on a SATA connector are 3.3 VDC, 5 VDC, and 12 VDC.

   B. **Incorrect:** ATX power supplies do not provide 15 VDC.

   C. **Incorrect:** ATX power supplies do not provide 15 VDC.

   D. **Incorrect:** ATX power supplies do not provide 15 VDC or 24 VDC.

7. **Correct Answer:** C

   A. **Incorrect:** A power sag occurs when the commercial power is lower than normal, so commercial power doesn't protect against it.

   B. **Incorrect:** Power supplies convert AC to DC, but they cannot protect against power sags.

   C. **Correct:** An uninterruptible power supply (UPS) uses a battery backup to protect against power sags. Flickering lights are an indication of power sags.

   D. **Incorrect:** Material Safety Data Sheets (MSDSs) provide safety-related information for items used within a work environment.

8. **Correct Answers:** A, D

   A. **Correct:** Electrostatic discharge (ESD) wrist straps protect against ESD damage.

   B. **Incorrect:** Low humidity generates more static. Ideally, humidity should be around 50 percent.

   C. **Incorrect:** Carpets generate static easily, so it's best not to store computers on carpets.

   D. **Correct:** ESD mats also protect against ESD.

9. **Correct Answer:** B

   A. **Incorrect:** A surge suppressor will prevent power spikes from reaching a computer, but it doesn't measure voltages.

   B. **Correct:** A multimeter can measure DC voltages provided to a motherboard on the P1 connector.

   C. **Incorrect:** A power strip provides unprotected power to a system but doesn't measure voltage.

   D. **Incorrect:** A power supply tester can test an unconnected power supply, but it isn't used for a power supply plugged into a system.

10. **Correct Answer:** D

   A. **Incorrect:** Lint-free cloths are used to clean screens but would not be used for an excessive amount of dust.

   B. **Incorrect:** An antistatic vacuum cleaner could be used but a standard vacuum cleaner can cause ESD damage.

   C. **Incorrect:** Glass cleaner includes ammonia and alcohol, which might damage internal components.

   D. **Correct:** Compressed air would be the best choice for blowing out the dust.

11. **Correct Answer:** B

   A. **Incorrect:** Case fans keep a system cool but do not contribute to ESD damage.

   B. **Correct:** Static builds up on carpet, so placing computers on carpets can contribute to ESD damage.

   C. **Incorrect:** Touching the computer case while working on a computer helps keep you at the same potential as the computer and reduces static buildup.

   D. **Incorrect:** ESD mats reduce the potential for ESD damage.

12. **Correct Answer:** A

   A. **Correct:** A Material Safety Data Sheet (MSDS) documents characteristics of materials used within a workplace.

   B. **Incorrect:** You might be able to find the information on the Internet, but an MSDS sheet should be readily available.

   C. **Incorrect:** Medical personnel will likely want to know what was in the cleaning compound, but they wouldn't know what was used.

   D. **Incorrect:** Coworkers wouldn't be the best source to identify the contents, but they can retrieve the MSDS.