CHAPTER 1

First Look at Computer Parts and Tools

In this chapter, you will learn:

- About the various parts inside a computer case and how they connect together and are compatible
- How to protect yourself and the equipment against the dangers of electricity when working inside a computer case
- About tools you will need as a PC hardware technician and safety precautions when working around computer equipment

Like many other computer users, you have probably used your personal computer to play games, update your Facebook profile, write papers, or build Excel worksheets. This book takes you from being an end user of your computer to becoming a PC support technician. The only assumption made here is that you are a computer user—that is, you can turn on your machine, load a software package, and use that software to accomplish a task. No experience in electronics is assumed.

As a PC support technician, you'll want to become A+ certified, which is the industry standard certification for PC support technicians. This book prepares you to pass the A+ 220-801 exam and the A+ 220-802 exam by CompTIA (*www.comptia.org*). These two exams are required by CompTIA for A+ Certification. The A+ 220-801 exam is primarily about hardware and customer service. The A+ 220-802 exam is primarily about software and also includes troubleshooting both software and hardware. This book fully prepares you for both exams needed for CompTIA A+ certification.

In this chapter, you learn to recognize various hardware components you'll find inside a computer case and about the tools you'll need to work inside the case. In the next chapter, you'll learn to take a computer apart and reassemble it. Consider these two chapters your one-two punch toward becoming a hardware technician.

A+ Exam Tip As you work your way through a chapter, notice the green and blue A+ mapping icons in the margins. These page elements help you know to which objectives on which exam the content applies. At the end of each chapter, take a look at the grid at the beginning of this book and make sure you understand each objective listed in the grid that is covered in the chapter.

WHAT'S INSIDE THE CASE

A+ 220-801 1.7, 1.8, 1.11

Before we discuss the parts inside a computer case, let's take a quick look at the case and the ports and switches on it. The computer case, sometimes called the chassis, houses the power supply, motherboard, processor, memory modules, expansion cards, hard drive, optical drive, and other drives. A computer case can be a tower case, a desktop case that lies flat on a desk, an all-in-one case used with an all-in-one computer, or a mobile case used with laptops and tablet PCs. A **tower case** (see Figure 1-1) sits upright and can be as high as two feet and has room for several drives. Often used for servers, this type of case is also good for PC users who anticipate upgrading because tower cases provide maximum space for working inside a computer and moving components around. A **desktop case** lies flat and sometimes serves double-duty as a monitor stand. In this chapter and the next, you learn how to work inside a tower or desktop case, and in Chapter 19, you learn how to work inside a laptop case and all-in-one case.

Figure 1-1 This slimline tower case supports a MicroATX motherboard

Notes When a computer using a desktop case is in use, don't sit the case on its end that is designed to lie flat because the CD or DVD drive might not work properly.

Table 1-1 lists ports you might find on a laptop or desktop computer. Consider this table your introduction to these ports so that you can recognize them when you see them. Later in the book, you learn more about the details of each port.

A+ Exam Tip The A+ 220-801 exam expects you to know how to identify the ports shown in Table 1-1.

A+ 220-801 1.7, 1.8, 1.11

Port	Description
 © Cengage Learning 2014	A **VGA (Video Graphics Array) port**, also called a **DB-15 port**, is a 15-pin female port that transmits analog video. (Analog means a continuous signal with infinite variations as compared to digital, which is a series of binary values—1s and 0s.) All older monitors use VGA ports.
 © Cengage Learning 2014	An **S-Video port** is a 4-pin or 7-pin round video port sometimes used to connect to a television. The 7-pin port is shown on the left. The 4-pin port is missing the extra pins in the middle and is the more common type.
 © Cengage Learning 2014	A **DVI (Digital Video Interface) port** transmits digital or analog video. Three types of DVI ports exist, which you learn about in Chapter 8.
 © Cengage Learning 2014	An **HDMI (High-Definition Multimedia Interface) port** transmits digital video and audio (not analog transmissions) and is often used to connect to home theater equipment.
 © Cengage Learning 2014	A **DisplayPort** transmits digital video and audio (not analog transmissions) and is slowly replacing VGA and DVI ports on personal computers.
 Courtesy of Creative Commons Attribution 3.0, Macfan97	A **Thunderbolt** port transmits both video and data on the same port and cable. The port is shaped the same as the DisplayPort and is compatible with DisplayPort devices.
 © Cengage Learning 2014	A **network port**, also called an **Ethernet port**, or an **RJ-45** port, is used by a network cable to connect to the wired network. Fast Ethernet ports run at 100 Mbps (megabits per second), and Gigabit Ethernet runs at 1,000 Mbps or 1 Gbps (gigabit per second). A megabit is one million bits and a gigabit is one billion bits. A bit is a binary value of one or zero.

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Table 1-1 Ports used with laptop and desktop computers (continues)

A+ 220-801 1.7, 1.8, 1.11

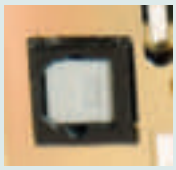
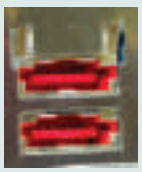
Port	Description
 © Cengage Learning 2014	A system usually has three or more round **audio ports**, also called sound ports, for a microphone, audio in, audio out, and stereo audio out. If you have one audio cable to connect to a speaker or ear buds, plug it into the lime green sound port in the middle of the three ports.
 © Cengage Learning 2014	An **S/PDIF (Sony-Philips Digital Interface) sound port** connects to an external home theater audio system, providing digital audio output and the best signal quality.
 © Cengage Learning 2014	A **USB (Universal Serial Bus) port** is a multi-purpose I/O port used by many different devices, including printers, mice, keyboards, scanners, external hard drives, and flash drives. Some USB ports are faster than others. Hi-Speed USB 2.0 is faster than regular USB, and Super-Speed USB 3.0 is faster than USB 2.0.
 © Cengage Learning 2014	A **FireWire port** (also called an **IEEE1394 port**, pronounced "I-triple-E 1394 port") is used for high-speed multimedia devices such as digital camcorders.
 © Cengage Learning 2014	An **external SATA (eSATA)** port is used by an external hard drive using the eSATA interface. eSATA is faster than FireWire.
 © Cengage Learning 2014	A **PS/2 port**, also called a mini-DIN port, is a round 6-pin port used by a keyboard or mouse. The ports look alike but are not interchangeable. On a PC, the purple port is for the keyboard, and the green port is for the mouse. Newer computers use USB ports for the keyboard and mouse rather than the older PS/2 ports.
 © Cengage Learning 2014	An older **serial port**, sometimes called a DB9 port, is a 9-pin male port used on older computers. It has been mostly replaced by USB ports.

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Table 1-1 Ports used with laptop and desktop computers (continues)

A+ 220-801 1.7, 1.8, 1.11

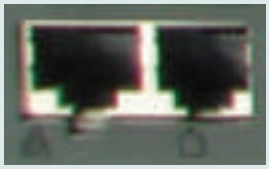
Port	Description
 © Cengage Learning 2014	A **parallel port** is a 25-pin female port used by older printers. This older port has been replaced by USB ports.
 © Cengage Learning 2014	A **modem port**, also called an **RJ-11** port, is used to connect dial-up phone lines to computers. A modem port looks like a network port but is not as wide. In the photo, the right port is a modem port and the left port is a network port, shown for comparison.

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Table 1-1 Ports used with laptop and desktop computers (continued)

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Video
Looking inside a PC

I know you're eager to open a case and work inside it, but first let's get familiar with the major components in the case and how to work with them safely so you don't fry a motherboard or bend delicate connectors. Figure 1-2 shows the inside of a computer case.

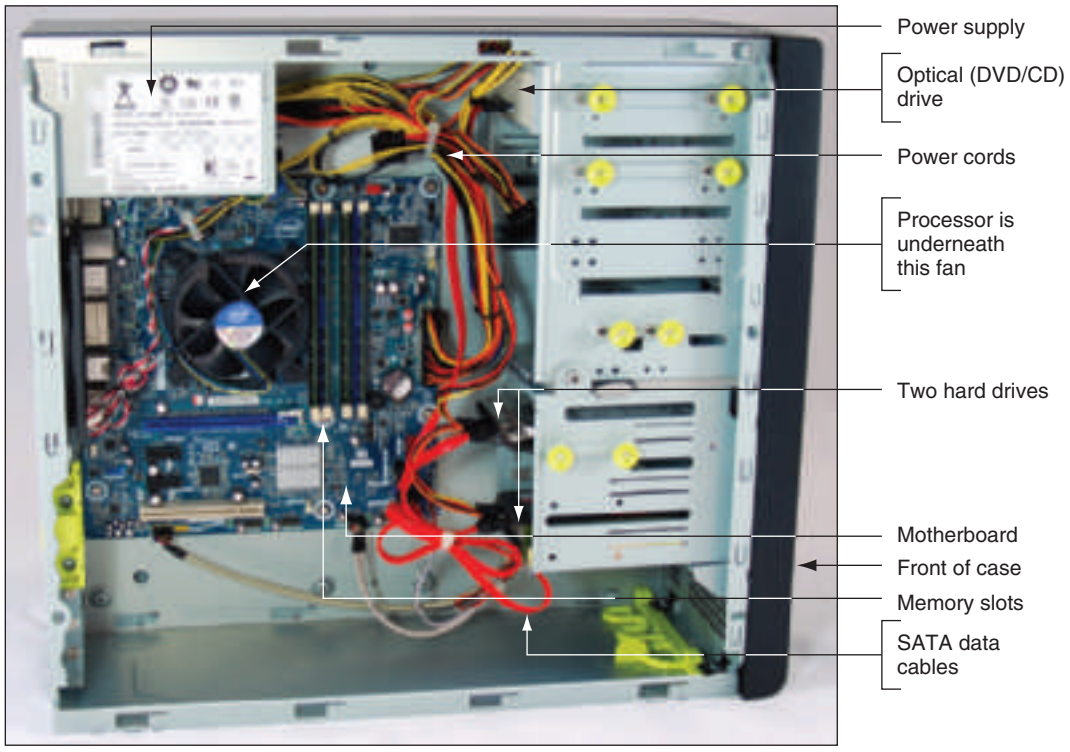

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Figure 1-2 Inside the computer case

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Here is a quick explanation of the main components installed in the case, which are called **internal components**:

- ***The motherboard, processor, and cooler.*** The **motherboard**, also called the **main board**, the **system board**, or the techie jargon term, the mobo, is the largest and most important circuit board in the computer. The motherboard contains a socket to hold the processor or CPU. The **central processing unit (CPU)**, also called the **processor** or **microprocessor**, does most of the processing of data and instructions for the entire system. Because the CPU generates heat, a fan and heat sink might be installed on top to keep it cool. A **heat sink** consists of metal fins that draw heat away from a component. The fan and heat sink together are called the processor cooler. Figure 1-3 shows the top view of a motherboard, and Figure 1-4 shows the ports on the side of a motherboard.

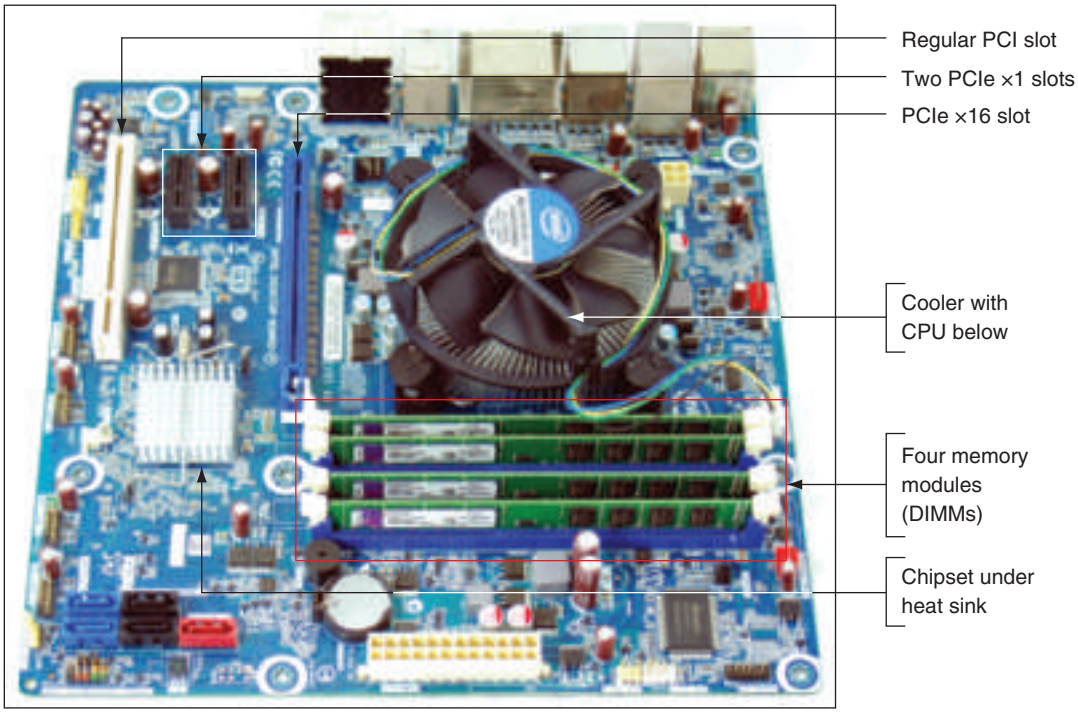

Figure 1-3 All hardware components are either located on the motherboard or directly or indirectly connected to it because they must all communicate with the CPU

- ***Expansion cards.*** A motherboard has expansion slots to be used by expansion cards. An **expansion card**, also called an adapter card, is a circuit board that provides more ports than those provided by the motherboard. Figure 1-5 shows a video card that provides three video ports. Notice the cooling fan and heat sink on the card, which help to keep the card from overheating. The trend today is for most ports in a system to be provided by the motherboard (called onboard ports) and less use of expansion cards.

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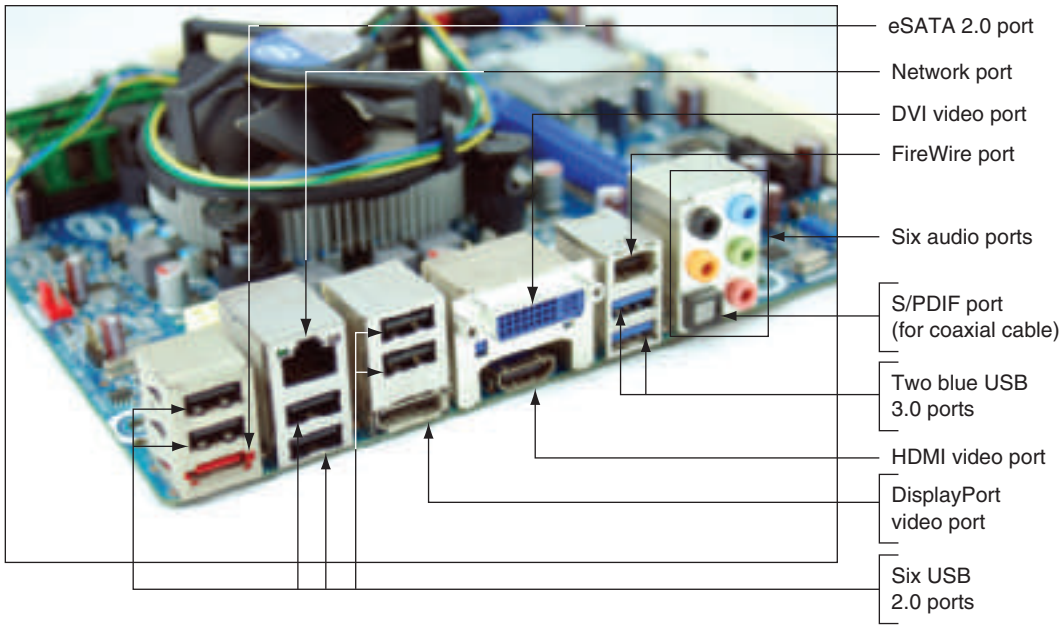

Figure 1-4 Ports provided by a motherboard

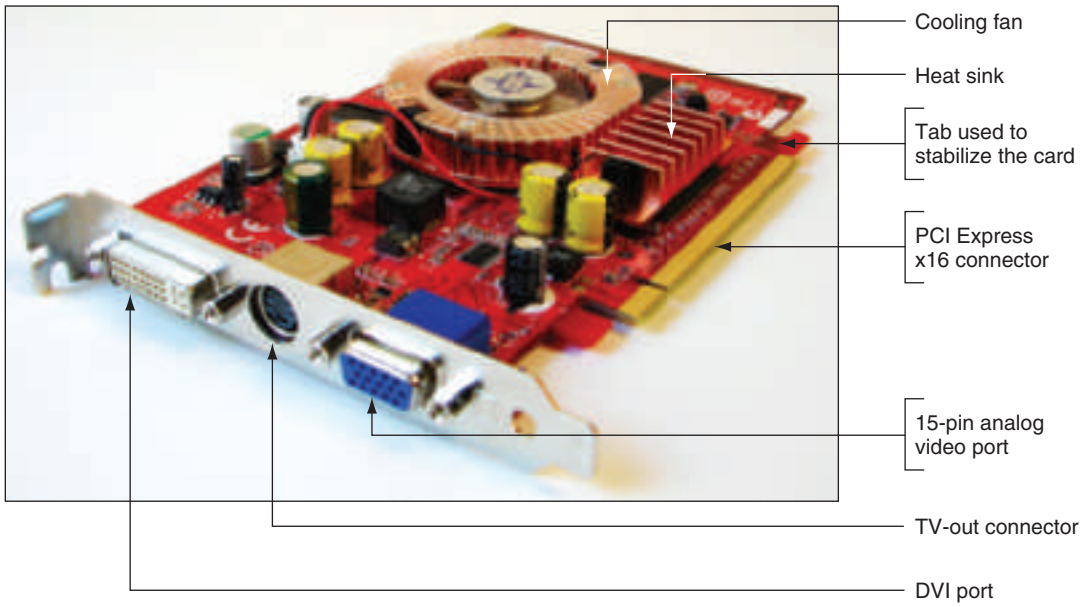

Figure 1-5 The easiest way to identify this video card is to look at the ports on the end of the card

- *Memory modules.* A motherboard has memory slots, called **DIMM (dual inline memory module)** slots, to hold memory modules. Figure 1-6 shows a memory module installed in one DIMM slot and three empty DIMM slots. Memory, also called **RAM (random access memory)**, is temporary storage for data and instructions as they are being processed by the CPU. The memory module shown in Figure 1-6 contains several RAM chips. Video cards also contain some embedded RAM chips for **video memory**.

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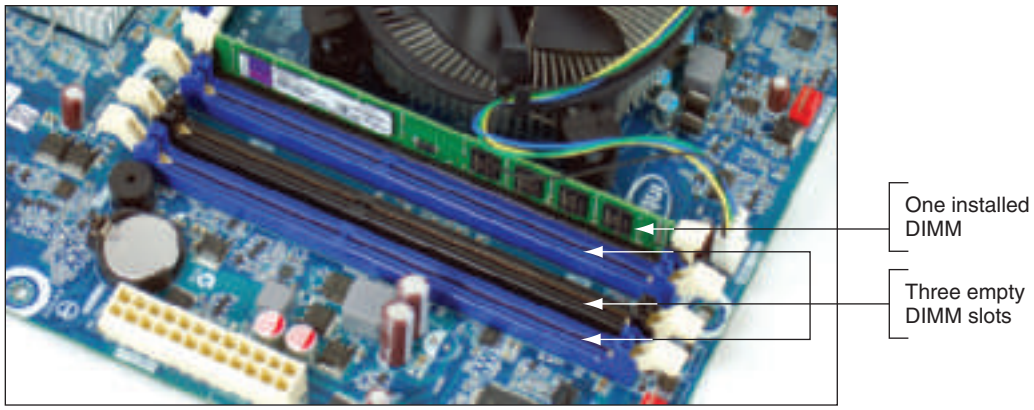

Figure 1-6 A DIMM holds RAM and is mounted directly on a motherboard

- ***Hard drives and other drives.*** A system might have one or more hard drives, an optical drive, a tape drive, or, for really old systems, a floppy drive. A **hard drive**, also called a **hard disk drive (HDD)**, is permanent storage used to hold data and programs. For example, the Windows 7 operating system and applications are installed on the hard drive. All drives in a system are installed in a stack of drive bays at the front of the case. The system shown in Figure 1-2 has two hard drives and one optical drive installed. These three drives are also shown in Figure 1-7. Each drive has two connections for cables: the power cable connects to the power supply and another cable, used for data and instructions, connects to the motherboard.

Figure 1-7 Two types of hard drives (larger magnetic drive and smaller solid state drive) and a DVD drive

- ***Power supply.*** A computer **power supply**, also known as a **power supply unit (PSU)**, is a box installed in a corner of the computer case (see Figure 1-8) that receives and converts the house current so that components inside the case can use it. Most power supplies have a **dual-voltage selector switch** on the back of the computer case where you can switch the input voltage to the power supply to 115 V used in the United States or 220 V used in other countries. See Figure 1-9. The power cables can connect to and supply power to the motherboard, expansion cards, and drives.

Notes If you ever need to change the dual-voltage selector switch, be sure you first turn off the computer and unplug the power supply.

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Figure 1-8 Power supply with attached power cables

Figure 1-9 The dual-voltage selector switch sets the input voltage to the power supply

FORM FACTORS USED BY COMPUTER CASES, POWER SUPPLIES, AND MOTHERBOARDS

The computer case, power supply, and motherboard must all be compatible and fit together as an interconnecting system. The standards that describe the size, shape, screw hole positions, and major features of these interconnected components are called **form factors**. Using a matching form factor for the motherboard, power supply, and case assures you that:

- The motherboard fits in the case.
- The power supply cords to the motherboard provide the correct voltage, and the connectors match the connections on the board.
- The holes in the motherboard align with the holes in the case for anchoring the board to the case.
- The holes in the case align with ports coming off the motherboard.

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- For some form factors, wires for switches and lights on the front of the case match up with connections on the motherboard.
- The holes in the power supply align with holes in the case for anchoring the power supply to the case.

The two form factors used by most desktop and tower computer cases and power supplies are the ATX and mini-ATX form factors. Motherboards use these and other form factors that are compatible with ATX or mini-ATX power supplies and cases. You learn about other motherboard form factors in Chapter 4. Following are the important details about ATX and mini-ATX.

ATX FORM FACTOR

ATX (Advanced Technology Extended) is the most commonly used form factor today. It is an open, nonproprietary industry specification originally developed by Intel in 1995 and has undergone several revisions since then. The original ATX form factor for cases had case fans blowing air into the case, but early revisions to the form factor had fans blowing air out of the case. Blowing air out of the case does a better job of keeping the system cool.

An ATX power supply has a variety of power connectors (see Figure 1-10). The power connectors are listed in Table 1-2 and several of them are described next.

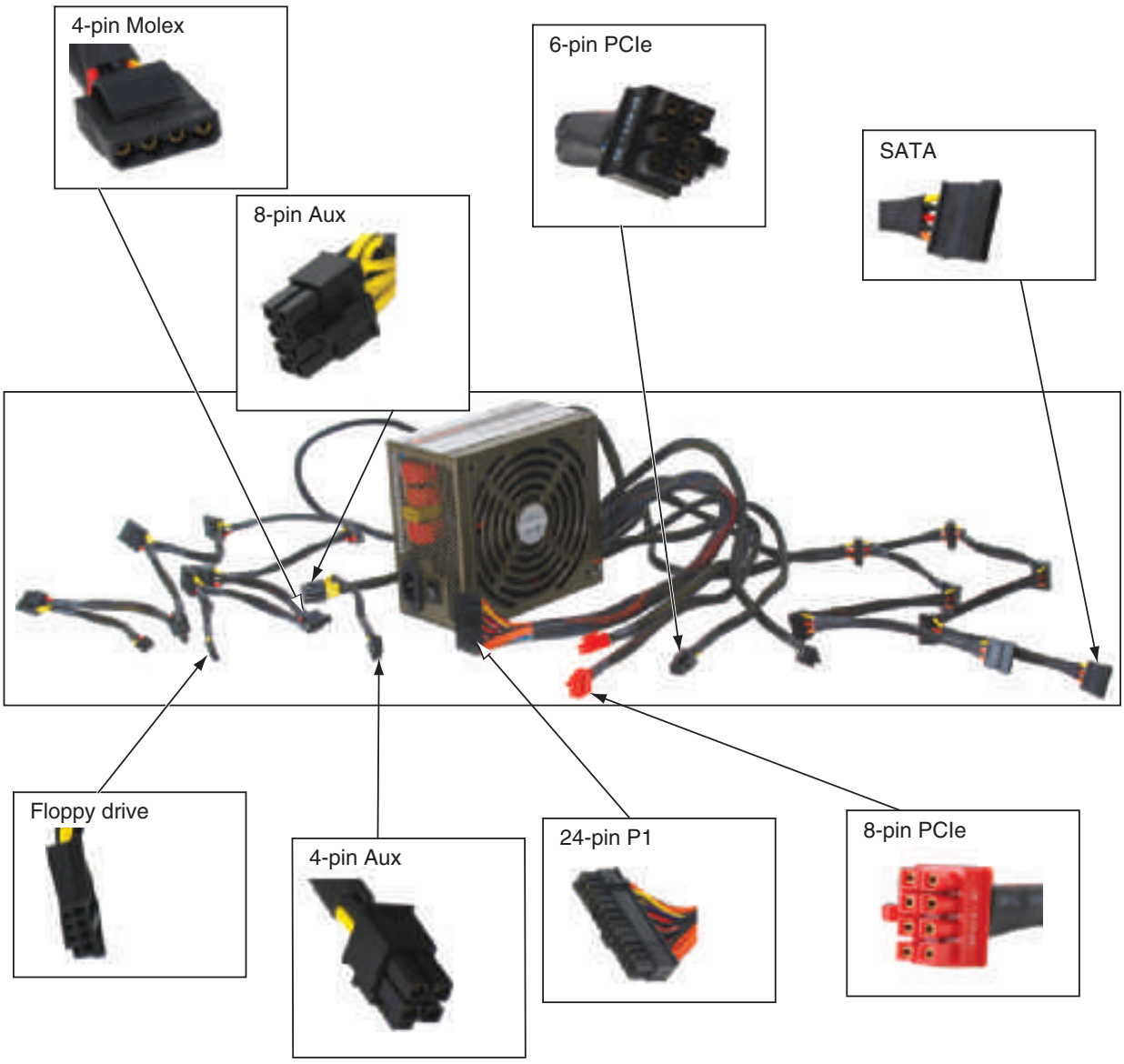

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Figure 1-10 ATX power supply with connectors

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Connector	Description
 © Cengage Learning 2014	20-pin P1 connect is the main motherboard power connector used in the early ATX systems
 © Cengage Learning 2014	24-pin P1 connector, also called the 20+4 pin connector, is the main motherboard power connector used today
 © Cengage Learning 2014	20+4 pin P1 connector with four pins removed so the connector can fit into a 20-pin P1 motherboard connector
 © Cengage Learning 2014	4-pin auxiliary motherboard connector used for extra 12 V power to the processor
 © Cengage Learning 2014	8-pin auxiliary motherboard connector used for extra 12 V power to the processor, providing more power than the older 4-pin auxiliary connector
 © Cengage Learning 2014	4-pin Molex connector is used for IDE (PATA) drives
 © Cengage Learning 2014	15-pin SATA connector used for SATA drives
 © Cengage Learning 2014	4-pin Berg connector used by a floppy disk drive (FDD)

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Table 1-2 Power supply connectors (continues)

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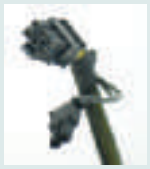
Connector	Description
 © Cengage Learning 2014	6-pin PCIe connector provides an extra +12 V for high-end video cards using PCI Express, Version 1 standard
 © Cengage Learning 2014	8-pin PCIe connector provides an extra +12 V for high-end video cards using PCI Express, Version 2
 © Cengage Learning 2014	6-pin plus 2-pin +12 V PCIe connector is used by high-end video cards using PCIe ×16 slots to provide extra voltage to the card. To get the 8-pin connector, combine both the 6-pin and 2-pin connectors.

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Table 1-2 Power supply connectors (continued)

A+ Exam Tip The A+ 220-801 exam expects you to know about each connector listed in Table 1-2.

Power connectors have evolved because components using new technologies require more power. As you read about the following types of power connectors and why each came to be, you'll also learn about the evolving expansion slots and expansion cards that drove the need for more power:

- ***20-pin P1 connector.*** The first ATX power supplies and motherboards used a single power connector called the P1 connector that had 20 pins. Figure 1-11 shows an ATX case with an ATX power supply installed, and Figure 1-12 shows the P1 connector on an ATX motherboard. The **20-pin P1 connector** used by the power supply and motherboard provided +3.3 volts, +5 volts, +12 volts, -12 volts, and an optional and rarely used -5 volts. This 20-pin power connector was sufficient for powering expansion cards installed in **PCI (Peripheral Component Interconnect)** expansion slots on the motherboard (see Figure 1-13). Several versions of PCI slots evolved over time, which you learn about in Chapter 4.
- ***4-pin and 8-pin auxiliary connectors.*** When processors began to require more power, the ATX Version 2.1 specifications added a **4-pin motherboard auxiliary connector** near the processor socket to provide an additional 12 V of power (see Figure 1-14). A power supply that provides this 4-pin 12 volt power cord is called an **ATX12V power supply**. Later boards replaced the 4-pin 12 volt power connector with an **8-pin motherboard auxiliary connector** that provided more amps for the processor.

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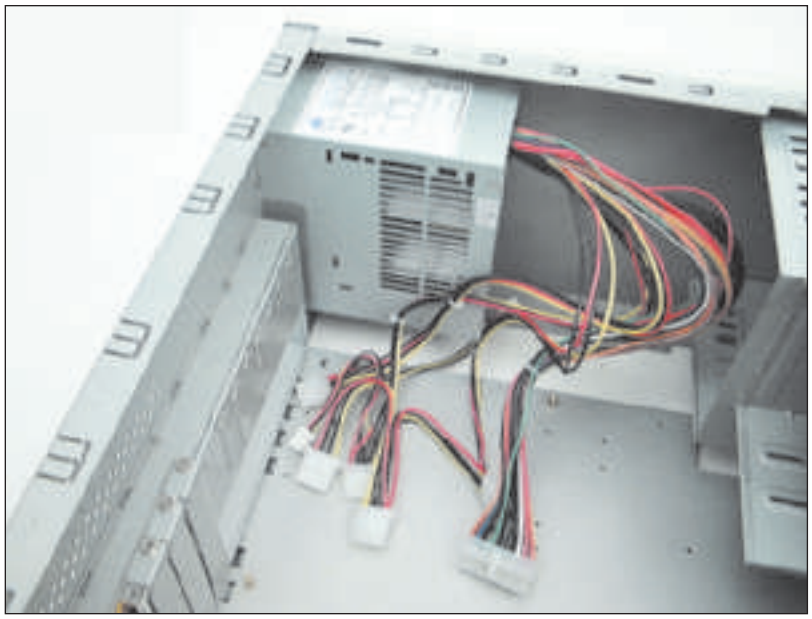

Figure 1-11 ATX power supply with connections

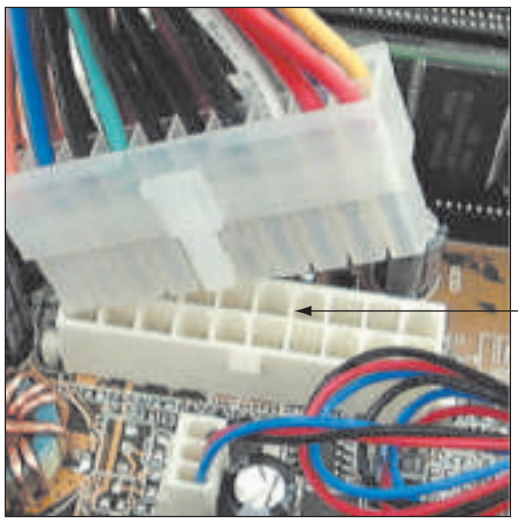

Figure 1-12 The first ATX P1 power connector used 20 pins

- ***24-pin or 20+4-pin P1 connector.*** Later, when faster **PCI Express (PCIe)** slots were added to motherboards, more power was required and a new ATX specification (ATX Version 2.2) allowed for a **24-pin P1 connector**, also called the 20+4 power connector. The 20-pin power cable will still work in the new 24-pin connector. Looking back at Figure 1-3, you can see one long blue PCIe ×16 slot (16 lanes for 16-bit transfers on this slot) that can be used by a video card and two short black PCIe ×1 slots (for 1-bit transfers) that can be used for other expansion cards that fit this type of slot.

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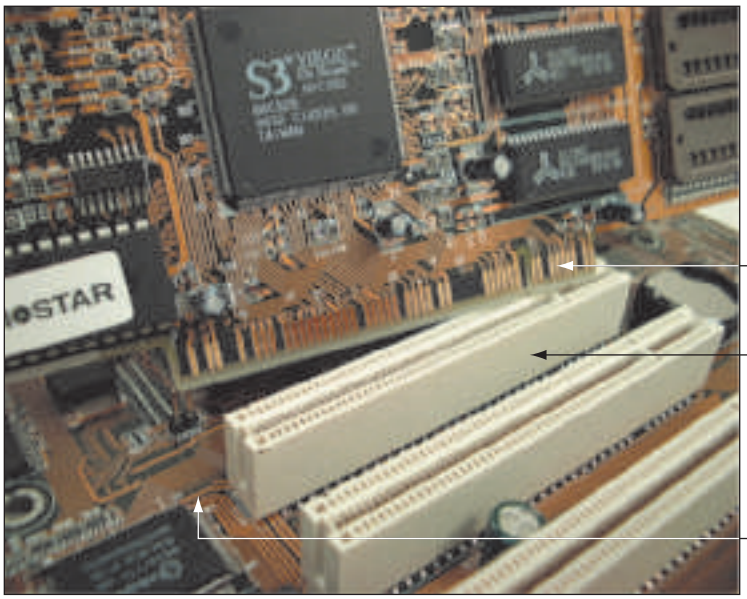

Figure 1-13 A PCI expansion card about to be installed in a PCI slot

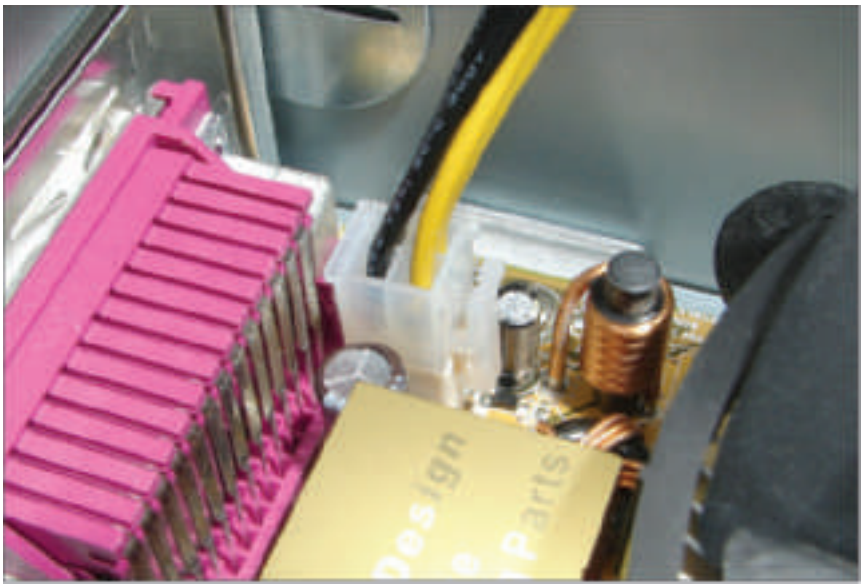

Figure 1-14 The 4-pin 12 volt auxiliary power connector on a motherboard with power cord connected

The extra 4 pins on the 24-pin P1 connector provide +12 volts, +5 volts, and +3.3 volts pins. Motherboards that support PCI Express and have the 24-pin P1 connector are sometimes called Enhanced ATX boards. Figure 1-15 shows a 20-pin P1 power cord from the power supply and a 24-pin P1 connector on a motherboard. Figure 1-16 shows the pinouts for the 24-pin power cord connector, which is color-coded to wires from the power supply. The 20-pin connector is missing the lower four pins, which are listed in the photo and diagram.

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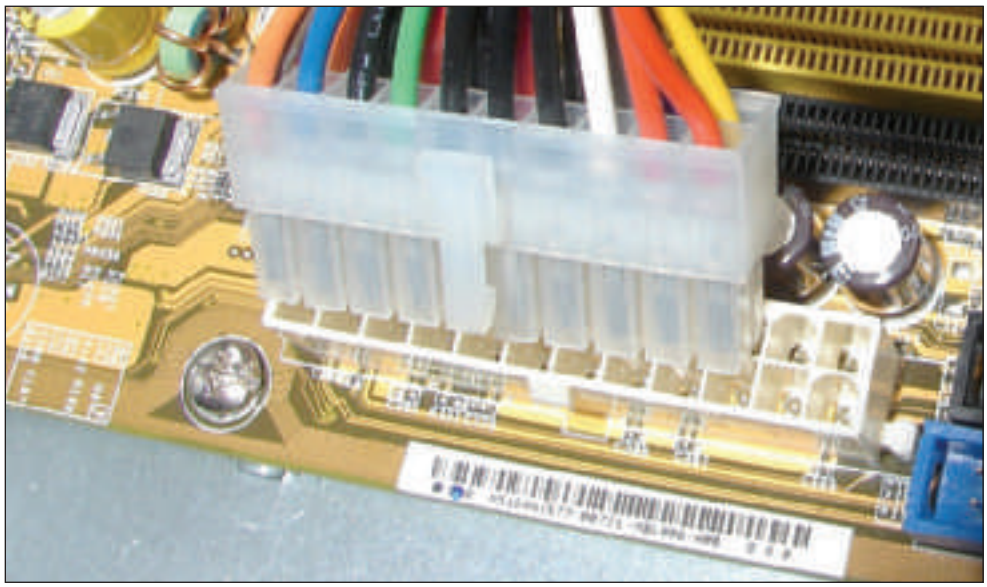

Figure 1-15 A 20-pin power cord ready to be plugged into a 24-pin P1 connector on an ATX motherboard

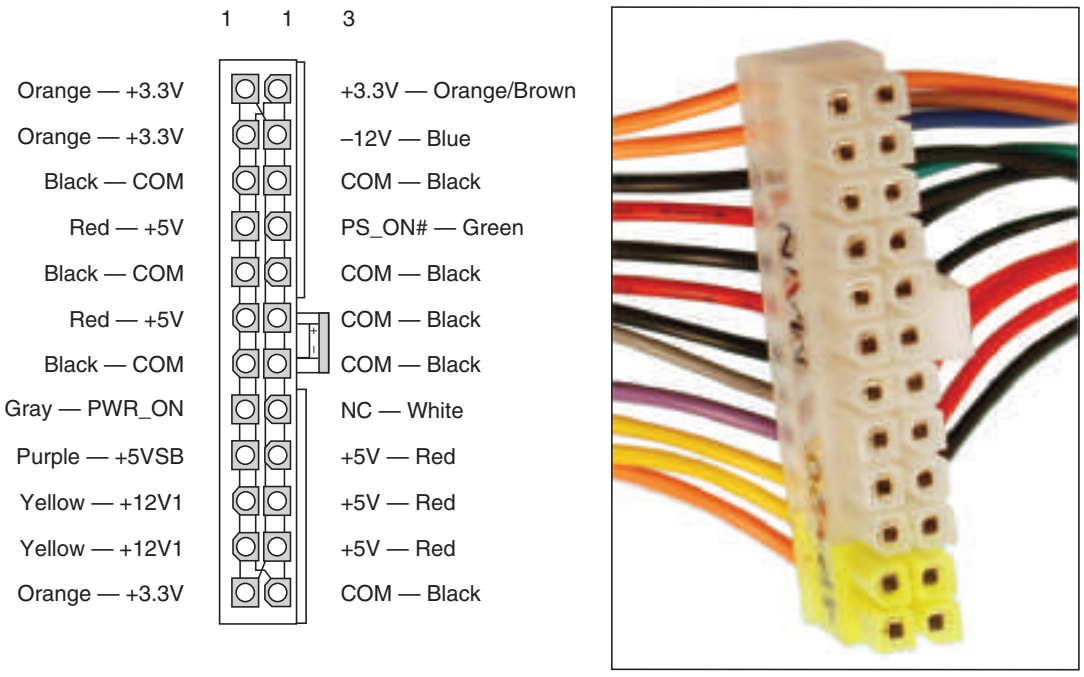

Figure 1-16 P1 24-pin power connector follows ATX Version 2.2 and higher standards

Figure 1-17 shows a PCIe ×16 video card. The edge connector has a break that fits the break in the slot. The tab at the end of the edge connector fits into a retention mechanism at the end of the slot, which helps to stabilize a heavy video card.

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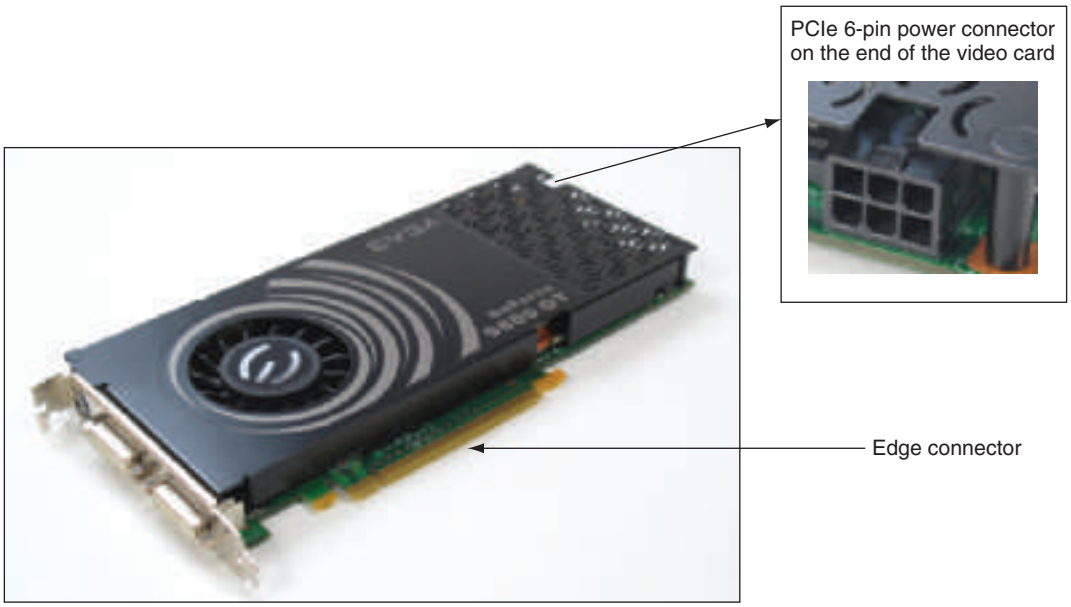

Figure 1-17 This PCIe ×16 video card has a 6-pin PCIe power connector to receive extra power from the power supply

- ***6-pin and 8-pin PCIe connectors.*** Video cards draw the most power in a system, and ATX Version 2.2 provides for power cables to connect directly to a video card to provide it additional power than comes through the PCIe slot on the motherboard. The **PCIe power connector** might have 6 or 8 pins. PCI Express, Version 1, defined the 6-pin connector, and PCI Express, Version 2, defined the 8-pin connector. The video card shown in Figure 1-17 has a 6-pin connector on the top of the card. A 6- or 8-pin PCIe connector can also be located on the motherboard to supply extra power for the video card.

Notes For more information about all the form factors discussed in this chapter, check out the form factor web site sponsored by Intel at *www.formfactors.org*.

MICROATX FORM FACTOR

The **microATX (MATX)** form factor is a major variation of ATX and addresses some technologies that have emerged since the original development of ATX. MicroATX reduces the total cost of a system by reducing the number of expansion slots on the motherboard, reducing the power supplied to the board, and allowing for a smaller case size. A microATX motherboard (see Figure 1-18) will fit into a case that follows the ATX 2.1 or higher standard. A microATX power supply uses a 24-pin P1 connector and is not likely to have as many extra wires and connectors as those on an ATX power supply.

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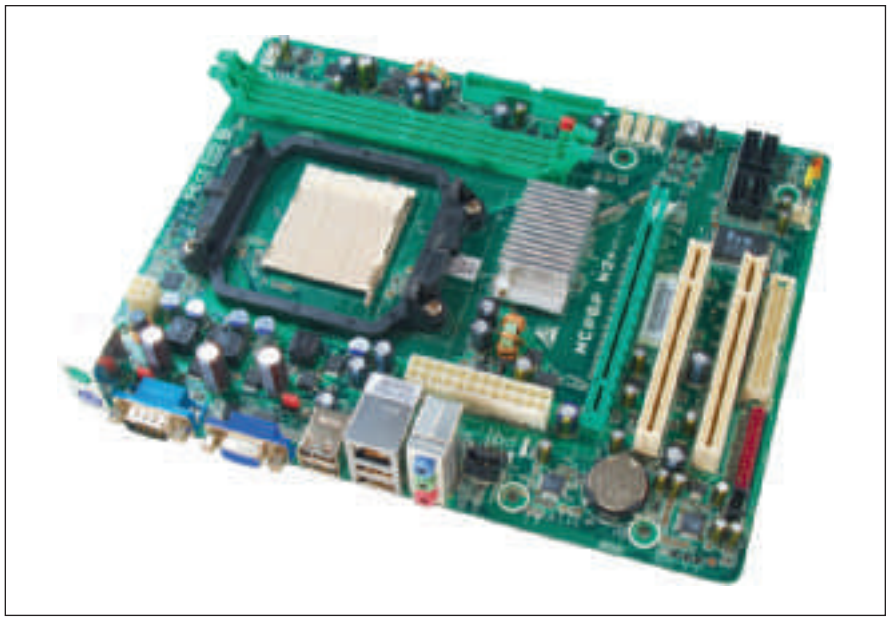

Figure 1-18 This MicroATX motherboard by Biostar is designed to support an AMD processor

A+ Exam Tip The A+ 220-801 exam expects you to recognize and know the more important features of the ATX and micro-ATX form factors used by power supplies.

Hands-on Project 1-1 Identify Ports and Parts

Do the following to identify computer ports and parts that your instructor might have on display:

1. Look on the front and back of your computer case and list the type of ports the computer offers.
2. For a power supply, list the number and type of power connectors.
3. For a motherboard, list the number and type of expansion slots on the board. Does the board have a 20-pin or 24-pin P1 connector? What other power connectors are on the board? How many memory slots does the board have?
4. For expansion cards, examine the ports on the back of the card. By examining the ports, can you tell the purpose of the card? What type of slot does the card use?

Caution Later in the chapter, you learn that you can damage a computer component with static electricity if you touch the component when you are not grounded. Before you touch a sensitive computer component, you first need to dissipate any static electricity on your body. You learn how to do that later in the chapter. For now, to protect a working component your instructor has on display, don't touch; just look.

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Hands-on Project 1-2 Examine the Power Supply, Motherboard, and Expansion Cards Inside a Case

If you have access to a computer with the case cover removed, examine its components and answer the following questions. As you look, remember to not touch anything inside the case unless you are properly grounded.

1. Identify the power supply, motherboard, and any expansion cards that might be installed on the motherboard. Remember: Don't touch a component unless you are properly grounded. If the case is plugged into a power source, don't touch inside the case even if you are grounded.
2. Identify the cooler that is installed on top of the processor. This cooler is likely to have a fan on top and a heat sink that you cannot see. The processor is hidden under the cooler.
3. Identify the memory modules and memory slots. How many memory slots are there? How many of these slots are populated?
4. If an expansion card is installed, what type of ports does the card provide at the rear of the case? Find the one screw that is used to attach the expansion card to the case.
5. Locate the screws that are attaching the motherboard to the case. How many screws are used? Do you see screw holes in the motherboard that are not being used? As a general rule of thumb, up to nine screws can be used to attach a motherboard to a case.
6. How many power cables are coming from the power supply? How many of these cables are connected to the motherboard? To other devices inside the computer? Identify each type of power cable the system is using.
7. Find the screws or clips that are attaching the power supply to the case. Is the power supply attached using screws, clips, or both screws and clips?

Now let's learn about the drives you might find installed inside a system.

DRIVES, THEIR CABLES, AND CONNECTORS

A computer might have one or more hard drives, an optical drive (CD, DVD, or Blu-ray), tape drive, floppy drive, or some other type of drive. A drive receives power by a power cable from the power supply and communicates instructions and data through a cable attached to the motherboard. Two standards that hard drives, optical drives, and tape drives use for both types of connections are the faster **serial ATA (SATA)** standard and the slower and older **parallel ATA (PATA)** standard. Both standards are published by the American National Standards Institute (ANSI, see *www.ansi.org*). Most drives today use the faster SATA interface. Figure 1-19 shows a SATA cable connecting a hard drive and motherboard. SATA cables can only connect to a SATA connector on the motherboard in one direction (see Figure 1-20). SATA drives get their power from a power cable that connects to the drive using a **SATA power connector** (refer back to the photo in Table 1-2).

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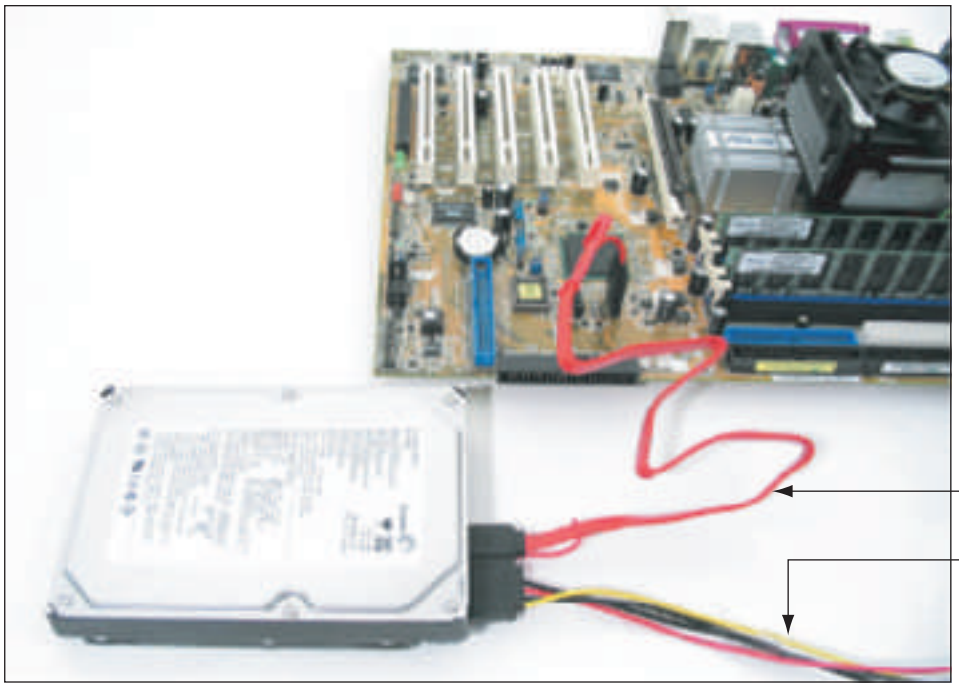

Figure 1-19 A hard drive subsystem using the SATA data cable

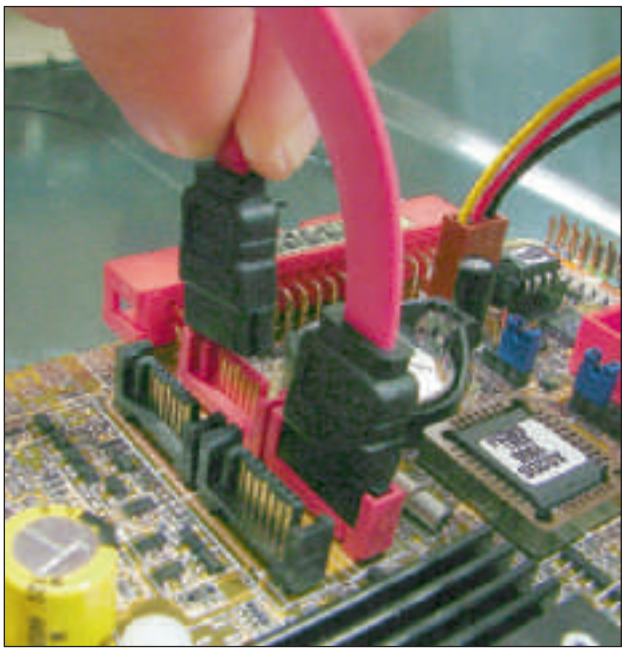

Figure 1-20 A SATA cable connects to a SATA connector in only one direction; use red connectors on the motherboard first

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The PATA interface, also called the IDE interface, uses a wide 40-pin ribbon cable and connector. The standard allows for only two connectors on a motherboard for two data cables (see Figure 1-21). Each IDE ribbon cable has a connection at the other end for an IDE drive and a connection in the middle of the cable for a second IDE drive. See Figure 1-22. Using this interface, a motherboard can accommodate up to four IDE or PATA drives in one system.

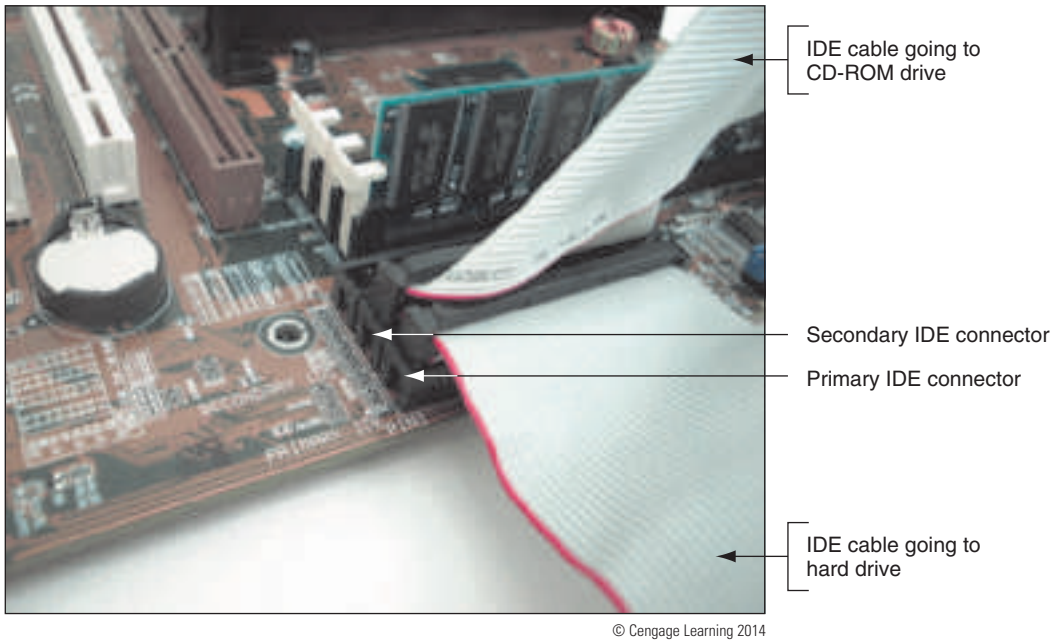

Figure 1-21 Using a parallel ATA interface, a motherboard has two IDE connectors, each of which can accommodate two devices; a hard drive usually connects to the motherboard using the primary IDE connector

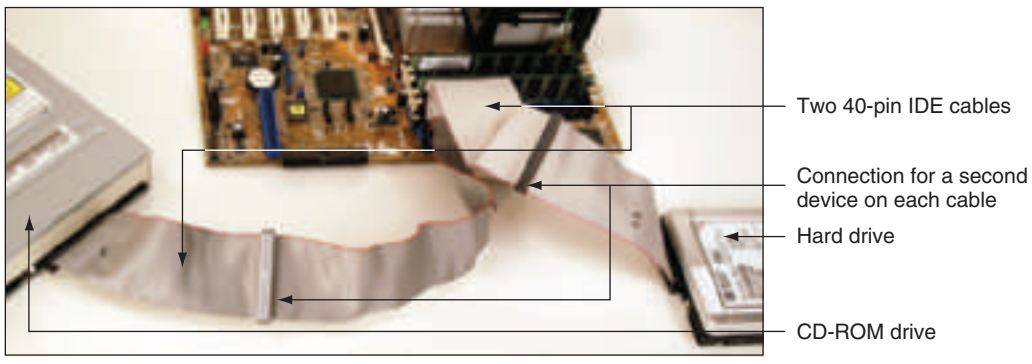

Figure 1-22 Two IDE devices connected to a motherboard using both IDE connections and two cables

PATA drives use a 4-pin power connector called a **Molex power connector**. A Molex connector is shaped so it connects in only one direction (see Figure 1-23).

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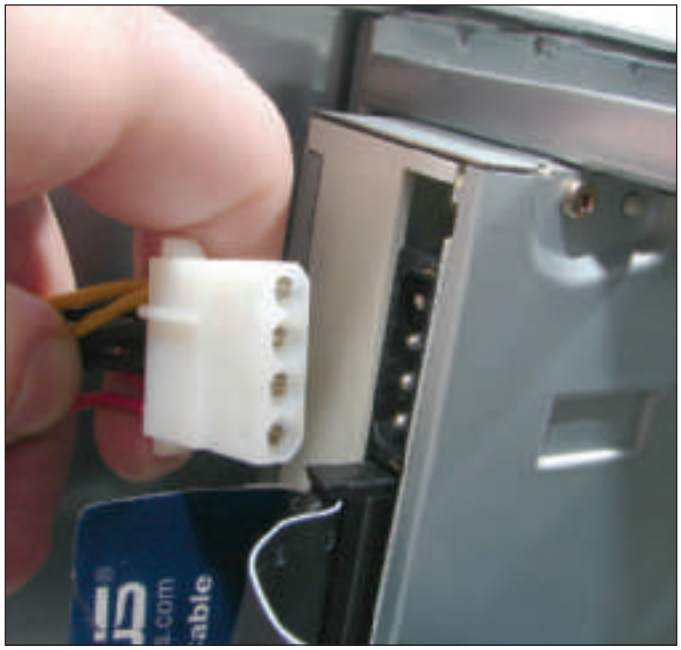

Figure 1-23 Molex power connector to a drive is shaped so that it orients in only one direction

Older motherboards provide a connection for a floppy drive data cable (see Figure 1-24). A **floppy drive**, also called a **floppy disk drive (FDD)**, can hold 3.5 inch disks containing up to 1.44 MB of data. The floppy drive cable has 34 pins and a twist in the cable and can accommodate one or two drives (see Figure 1-25). The drive at the end of the cable is drive A, which is the drive that follows the twist in the cable. If another drive were connected to the middle of the cable, it would be drive B in a computer system, which is the drive before the twist. The 4-pin **Berg power connector** used by floppy drives is smaller than a Molex connector (see the photos in Table 1-2).

Figure 1-24 An older motherboard usually provides a connection for a floppy drive cable

Cables used by PATA drives might be a 40-pin conductor IDE cable or a higher-quality 80-conductor IDE cable used by the Enhanced IDE (EIDE) standards. (An 80-conductor cable has 80 thin wires connected to 40 pins.) Figure 1-26 shows the two IDE cables on the right and a floppy drive cable on the left. IDE and floppy drive cables have a red

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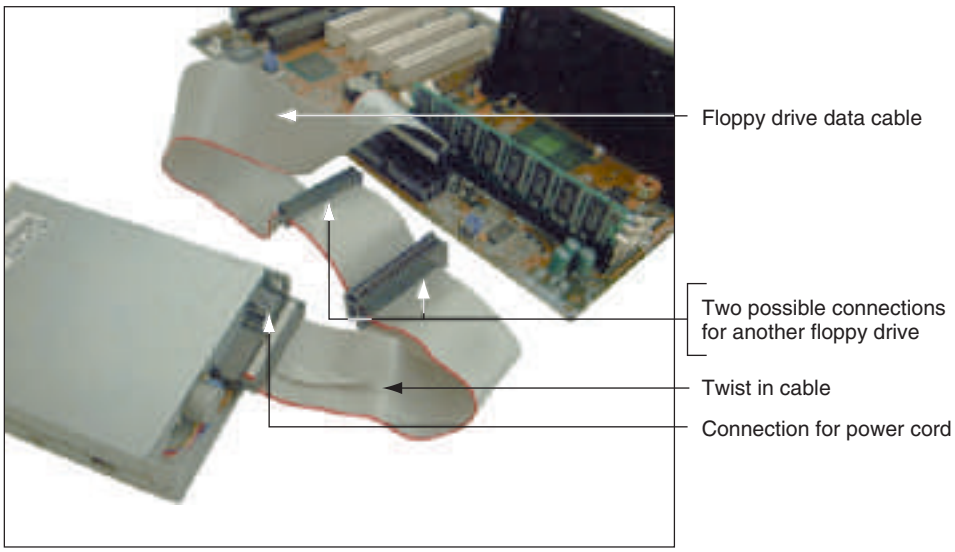

Figure 1-25 One floppy drive connection on a motherboard can support one or two floppy drives

color or stripe down one side of the cable. This edge color marks this side of the cable as pin 1. Pin 1 is labeled on the connector so that you can orient the cable in the connector (see Figure 1-27). The EIDE cables and some floppy drive cables have a covered pinhole and a notch in the motherboard connector, so these cables can connect in only one direction. See Figure 1-28.

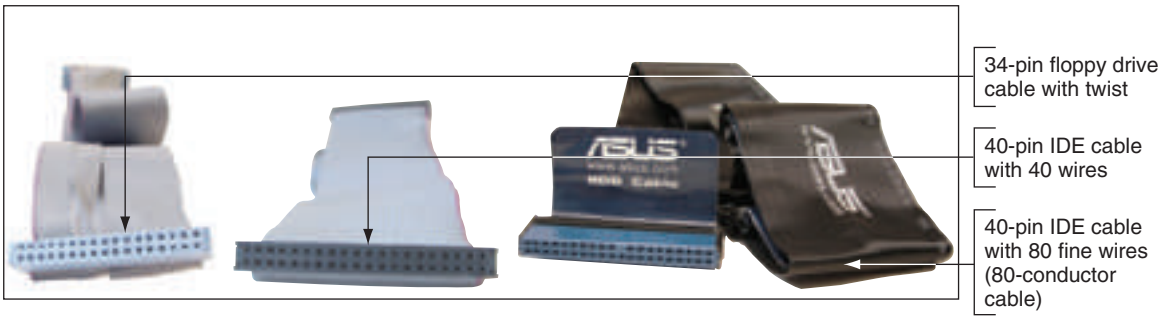

Figure 1-26 A system might have up to three types of ribbon cables

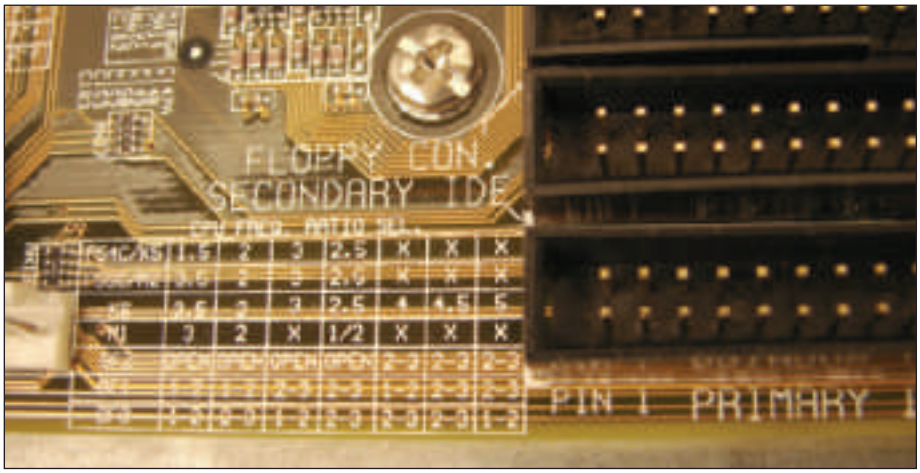

Figure 1-27 Pin 1 for this IDE connection is clearly marked

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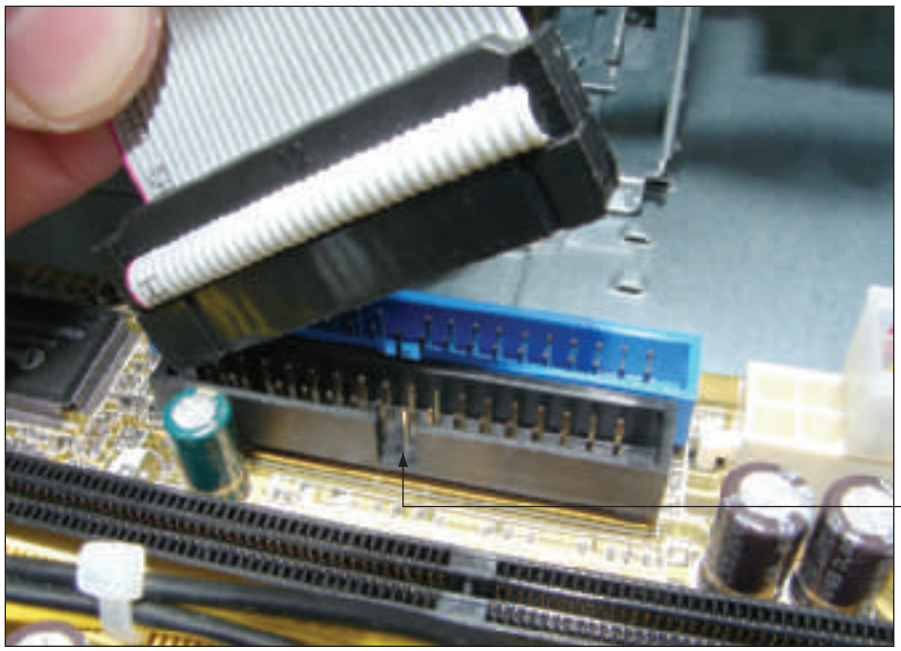

Figure 1-28 The notch on the side of this floppy drive connector allows the floppy drive cable to connect in only one direction

Hands-on Project 1-3 Identify Drives and Their Connectors

If your instructor has provided a display of drives, for each drive identify the purpose of the drive (for example, a hard drive or optical drive) and the type of interface the drive uses (for example, IDE or SATA). If you have access to a computer with the case cover removed, answer the following questions:

1. List the drives installed, the purpose of each drive, and the type of interface and power connector it uses.
2. How many connectors does the motherboard have for drives? Identify each type of connector (SATA, IDE, or floppy drive connector).

And this brings us to the fact that you need to know about electricity, how a computer uses it, and how to protect yourself and the equipment against electrical dangers.

PROTECTING YOURSELF AND THE EQUIPMENT AGAINST ELECTRICAL DANGERS

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By the end of the next chapter, you will know how to take a working desktop computer apart and put the computer back together. When you're done, it's expected the computer will still work! That might not be the case, however, if you don't understand electricity and how to protect yourself and the equipment against it. In this part of the chapter, you learn how to keep from getting a shock or damaging a component. Let's begin with a discussion of the basics of electricity.

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MEASURES AND PROPERTIES OF ELECTRICITY

In our modern world, we take electricity for granted, and we miss it terribly when it's cut off. Nearly everyone depends on it, but few really understand it. A successful PC support technician is not one who tends to encounter failed processors, fried motherboards, smoking monitors, or frizzed hair. To avoid these excitements, you need to understand how to measure electricity and how to protect computer equipment from its damaging power.

Let's start with the basics. To most people, volts, ohms, joules, watts, and amps are vague terms that simply mean electricity. All these terms can be used to measure some characteristic of electricity, as listed in Table 1-3.

Unit	Definition	Computer Example
Volt (for example, 115 V)	A measure of electrical force measured in **volts**. The symbol for volts is V.	A power supply steps down the voltage from the 115 volt house current to 3.3, 5, and 12 volts that computer components can use.
Amp or ampere (for example, 1.5 A)	An **amp** is a measure of electrical current. The symbol for amps is A.	An LCD monitor requires about 5 A to operate. A small laser printer uses about 2 A. A CD-ROM drive uses about 1 A.
Ohm (for example, 20 Ω)	An **ohm** is a measure of resistance to electricity. The symbol for ohm is Ω.	Current can flow in typical computer cables and wires with a resistance of near zero Ω (ohm).
Joule (for example, 500 joules)	A measure of work or energy. One **joule** (pronounced "jewel") is the work required to push an electrical current of one amp through a resistance of one ohm.	A **surge suppressor** (see Figure 1-29) is rated in joules—the higher the better. The rating determines how much work it can expend before it can no longer protect the circuit from a power surge.
Watt (for example, 20 W)	A measure of electrical power. One **watt** is one joule per second and measures the total electrical power needed to operate a device. Watts can be calculated by multiplying volts by amps. The symbol for watts is W.	The power consumption of an LCD computer monitor is rated at about 14 W. A DVD burner uses about 25 W when burning a DVD.

Table 1-3 Measures of electricity

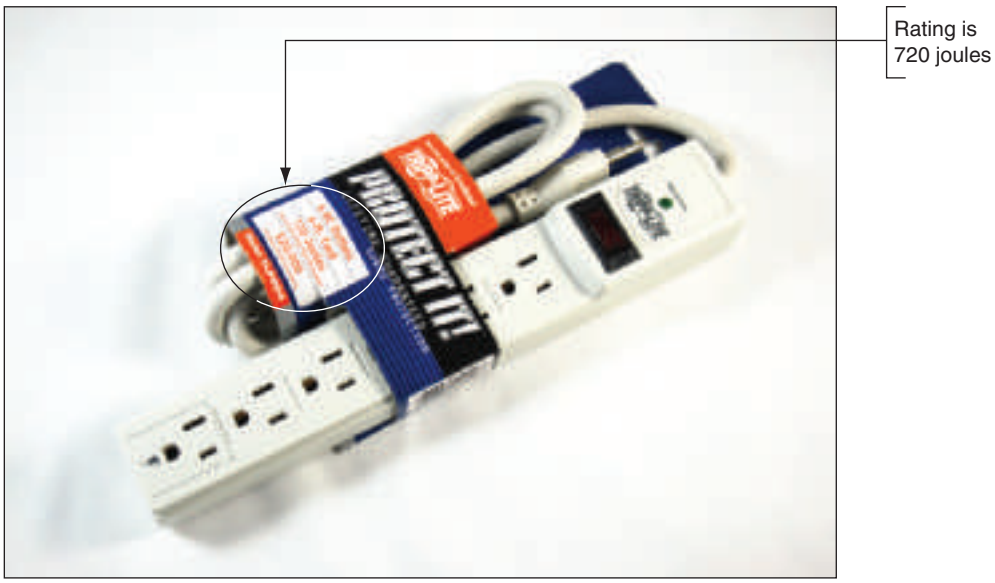

Figure 1-29 A surge suppressor protects electrical equipment from power surges and is rated in joules

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Notes To learn more about how volts, amps, ohms, joules, and watts measure the properties of electricity, see the content "Electricity and Multimeters" in the online content that accompanies this book at *cengagebrain.com*. To find out how to access this content, see the Preface to this book.

Now let's look at how electricity gets from one place to another and how it is used in house circuits and computers.

AC AND DC

Electricity can be either AC, alternating current, or DC, direct current. **Alternating current (AC)** goes back and forth, or oscillates, rather than traveling in only one direction. House current in the United States is AC and oscillates 60 times in one second (60 hertz). Voltage in the system is constantly alternating from positive to negative, which causes the electricity to flow first in one direction and then in the other. Voltage alternates from +115 V to -115 V. AC is the most economical way to transmit electricity to our homes and workplaces. By decreasing current and increasing voltage, we can force alternating current to travel great distances. When alternating current reaches its destination, it is made more suitable for driving our electrical devices by decreasing voltage and increasing current.

Direct current (DC) travels in only one direction and is the type of current that most electronic devices require, including computers. A **rectifier** is a device that converts AC to DC, and an **inverter** is a device that converts DC to AC. A **transformer** is a device that changes the ratio of voltage to current. The power supply used in computers is both a rectifier and a transformer.

Large transformers reduce the high voltage on power lines coming to your neighborhood to a lower voltage before the current enters your home. The transformer does not change the amount of power in this closed system; if it decreases voltage, it increases current. The overall power stays constant, but the ratio of voltage to current changes, as illustrated in Figure 1-30.

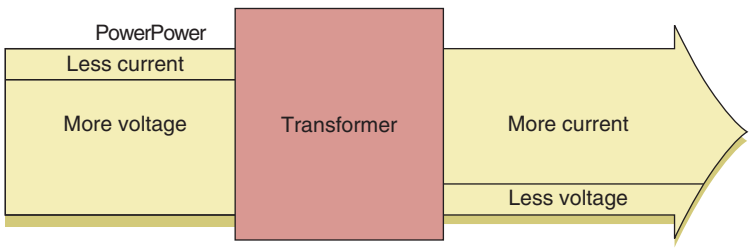

Figure 1-30 A transformer keeps power constant but changes the ratio of current to voltage

Direct current flows in only one direction. Think of electrical current like a current of water that flows from a state of high pressure to a state of low pressure or rest. Electrical current flows from a high-pressure state (called hot) to a state of rest (called ground or neutral). For a power supply, a power line may be either +5 or −5 volts in one circuit, or +12 or −12 volts in another circuit. The positive or negative value is determined by how the circuit is oriented, either on one side of the power output or the other. Several circuits coming from the power supply accommodate different devices with different power requirements.

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HOT, NEUTRAL, AND GROUND

AC travels on a hot line from the power station to a building and returns to the power station on a neutral line. When the two lines reach the building and enter an electrical device, such as a lamp, the device controls the flow of electricity between the hot and neutral lines. If an easier path (one with less resistance) is available, the electricity follows that path. This can cause a short, a sudden increase in flow that can also create a sudden increase in temperature—enough to start a fire and injure both people and equipment. Never put yourself in a position where you are the path of least resistance between the hot line and ground!

Caution It's very important that PC components be properly grounded. Never connect a PC to an outlet or use an extension cord that doesn't have the third ground plug. The third line can prevent a short from causing extreme damage. In addition, the bond between the neutral and ground helps eliminate electrical noise (stray electrical signals) within the PC that is sometimes caused by other electrical equipment sitting very close to the computer.

To prevent uncontrolled electricity in a short, the neutral line is grounded. Grounding a line means that the line is connected directly to the earth, so that, in the event of a short, the electricity flows into the earth and not back to the power station. Grounding serves as an escape route for out-of-control electricity because the earth is always capable of accepting a flow of current. With computers, a surge suppressor can be used to protect a computer and its components against power surges.

Caution Beware of the different uses of black wire. In PCs and in DC circuits, black is used for ground, but in home wiring and in AC circuits, black is used for hot!

The neutral line to your house is grounded many times along its way (in fact, at each electrical pole) and is also grounded at the breaker box where the electricity enters your house. You can look at a three-prong plug and see the three lines: hot, neutral, and ground (see Figure 1-31).

To verify that a wall outlet is wired correctly for hot, neutral, and ground, use a simple receptacle tester, as shown in Figure 1-32. Even though you might have a three-prong outlet in your home, the ground plug might not be properly grounded. To know for sure, you can test the outlet with a receptacle tester.

Notes House AC voltage in the United States is about 110–120 V, but know that in other countries, this is not always the case. In many other countries, the standard is 220 V. Outlet styles also vary from one country to the next.

Now that you know about electricity and how to protect a computer from surges and out-of-control electricity, let's turn our attention to protecting yourself against the dangers of electricity.

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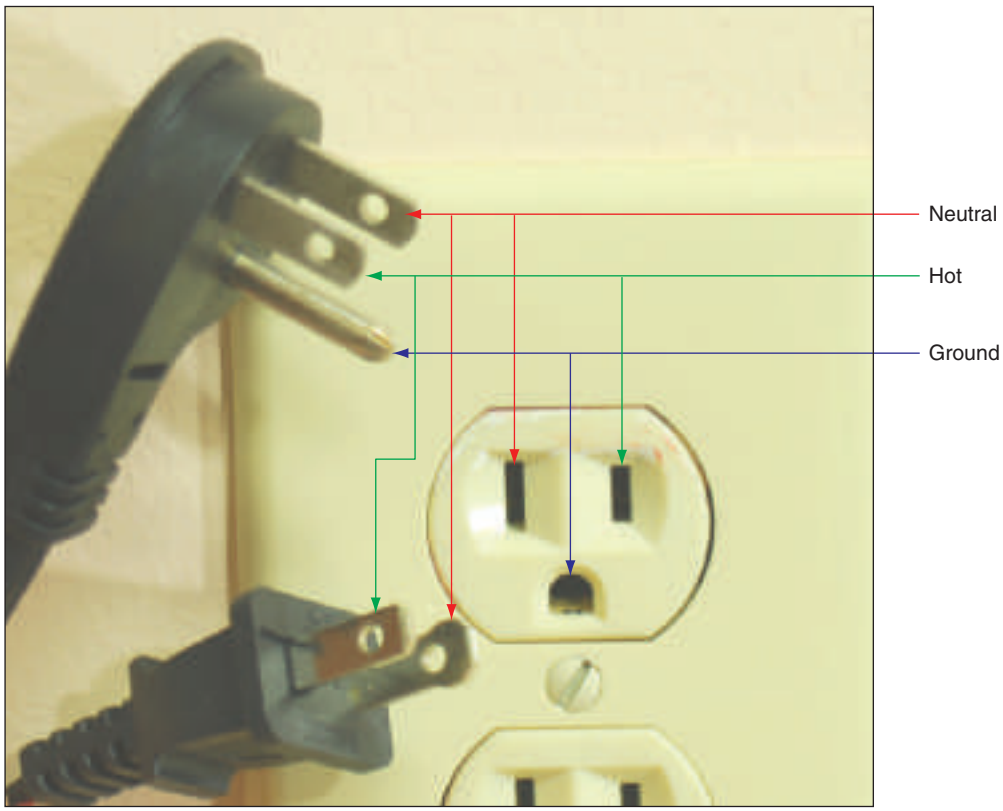

Figure 1-31 A polarized plug showing hot and neutral, and a three-prong plug showing hot, neutral, and ground

Figure 1-32 Use a receptacle tester to verify that hot, neutral, and ground are wired correctly

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PROTECT YOURSELF AGAINST ELECTRICAL SHOCK AND BURNS

To protect yourself against electrical shock, when working with any electrical device, including computers, printers, scanners, and network devices, disconnect the power if you notice a dangerous situation that might lead to electrical shock or fire. When you disconnect the power, do so by pulling on the plug at the AC outlet. To protect the power cord, don't pull on the cord itself. Also, don't just turn off the on/off switch on the device; you need to actually disconnect the power. Note that any of the following can indicate a potential danger:

- The power cord is frayed or otherwise damaged in any way.
- Water or other liquid is on the floor around the device or spilled on it.
- The device has been exposed to excess moisture.
- The device has been dropped or you notice physical damage.
- You smell a strong electronics odor.
- The power supply or fans are making a whining noise.
- You notice smoke coming from the computer case or the case feels unusually warm.

When working inside computers, printers, and other electrical devices, remove your jewelry that might come in contact with components. Jewelry is made of metal and might conduct electricity if it touches a component.

Power supplies and CRT monitors (the old-fashioned monitors that have a large case with a picture tube) contain capacitors. A capacitor holds its charge even after the power is turned off and the device is unplugged. A ground is the easiest possible path for electricity to follow. If you are grounded and touch a charged capacitor, its charge can flow through you to the ground, which can shock you! Therefore, if you ever work inside one of these devices, be careful that you are not grounded. Later in the chapter, you will learn that being grounded while working on sensitive low-voltage electronic equipment such as a motherboard or processor is a good thing, and the best way to ground yourself is to wear an antistatic grounding bracelet connected to ground. However, when working on a CRT monitor, power supply, or laser printer, *don't* wear the antistatic bracelet because you don't want to be ground for these high-voltage devices. How to work inside a power supply or CRT monitor is not covered in this book and is not considered a skill needed by an A+ certified support technician. The power supply and monitor are both considered to be a **field replaceable unit (FRU)**. That means, as a support technician, you are expected to know how to replace one when it breaks but not how to repair one.

A+ Exam Tip The A+ 220-801 exam expects you to know how to properly dispose of a CRT monitor.

Be sure a CRT monitor is discharged before you dispose of it. Most CRT monitors today are designed to discharge after sitting unplugged for 60 minutes. It can be manually discharged by using a high-voltage probe with the monitor case opened. Ask a technician trained to fix monitors to do this for you. Always follow local government regulations when disposing of computer equipment, monitors, printers, chemicals, and other substances that might be dangerous to the environment or humans.

Notes Go to *www.youtube.com* and search on "discharge a CRT monitor" to see some interesting videos that demonstrate the charge inside a monitor long after the monitor is turned off and unplugged. As for proper procedures, I'm not endorsing all these videos; just watch for fun.

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Never use water to put out a fire fueled by electricity because water is a conductor and you might get a severe electrical shock. A computer lab needs a fire extinguisher that is rated to put out electrical fires. Fire extinguishers are rated by the type of fires they put out:

- Class A extinguishers can use water to put out fires caused by wood, paper, and other combustibles.
- Class B extinguishers can put out fires caused by liquids such as gasoline, kerosene, and oil.
- **Class C fire extinguishers** use nonconductive chemicals to put out a fire caused by electricity. See Figure 1-33.

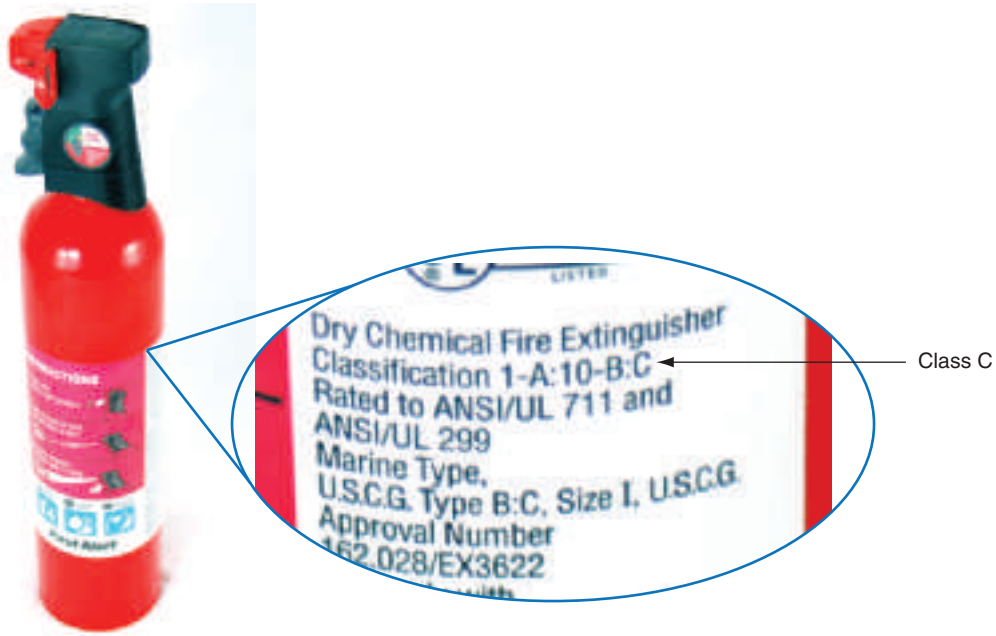

Figure 1-33 A Class C fire extinguisher is rated to put out electrical fires

PROTECT THE EQUIPMENT AGAINST STATIC ELECTRICITY OR ESD

Suppose you come indoors on a cold day, pick up a comb, and touch your hair. Sparks fly! What happened? Static electricity caused the sparks. **Electrostatic discharge (ESD)**, commonly known as **static electricity**, is an electrical charge at rest. When you came indoors, this charge built up on your hair and had no place to go. An ungrounded conductor (such as wire that is not touching another wire) or a nonconductive surface (such as your hair) holds a charge until the charge is released. When two objects with dissimilar electrical charges touch, electricity passes between them until the dissimilar charges become equal.

To see static charges equalizing, turn off the lights in a room, scuff your feet on the carpet, and touch another person. Occasionally, you can see and feel the charge in your fingers. If you can feel the charge, you discharged at least 1,500 volts of static electricity. If you hear the discharge, you released at least 6,000 volts. If you see the discharge, you released at least 8,000 volts of ESD. A charge of only 10 volts can damage electronic components! *You can touch a chip on an expansion card or motherboard, damage the chip with ESD, and never feel, hear, or see the electrical discharge.*

ESD can cause two types of damage in an electronic component: catastrophic failure and upset failure. A catastrophic failure destroys the component beyond use. An upset failure

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damages the component so that it does not perform well, even though it may still function to some degree. Upset failures are more difficult to detect because they are not consistent and not easily observed. Both types of failures permanently affect the device. Components are easily damaged by ESD, but because the damage might not show up for weeks or months, a technician is likely to get careless and not realize the damage he or she is doing.

Caution Unless you are measuring power levels with a multimeter, never, ever touch a component or cable inside a computer case while the power is on. The electrical voltage is not enough to seriously hurt you but more than enough to permanently damage the component.

Before touching or handling a component (for example, a hard drive, motherboard, expansion card, processor, or memory modules), to protect it against ESD, always ground yourself first. You can ground yourself and the computer parts by using one or more of the following static control devices or methods:

- ***Ground bracelet.*** A **ground bracelet**, also called an **ESD strap**, **antistatic wrist strap**, or ESD bracelet, is a strap you wear around your wrist. The strap has a cord attached with an alligator clip on the end. Attach the clip to the computer case you're working on, as shown in Figure 1-34. Any static electricity between you and the case is now discharged. Therefore, as you work inside the case, you will not damage the components with static electricity. The bracelet also contains a resistor that prevents electricity from harming you.

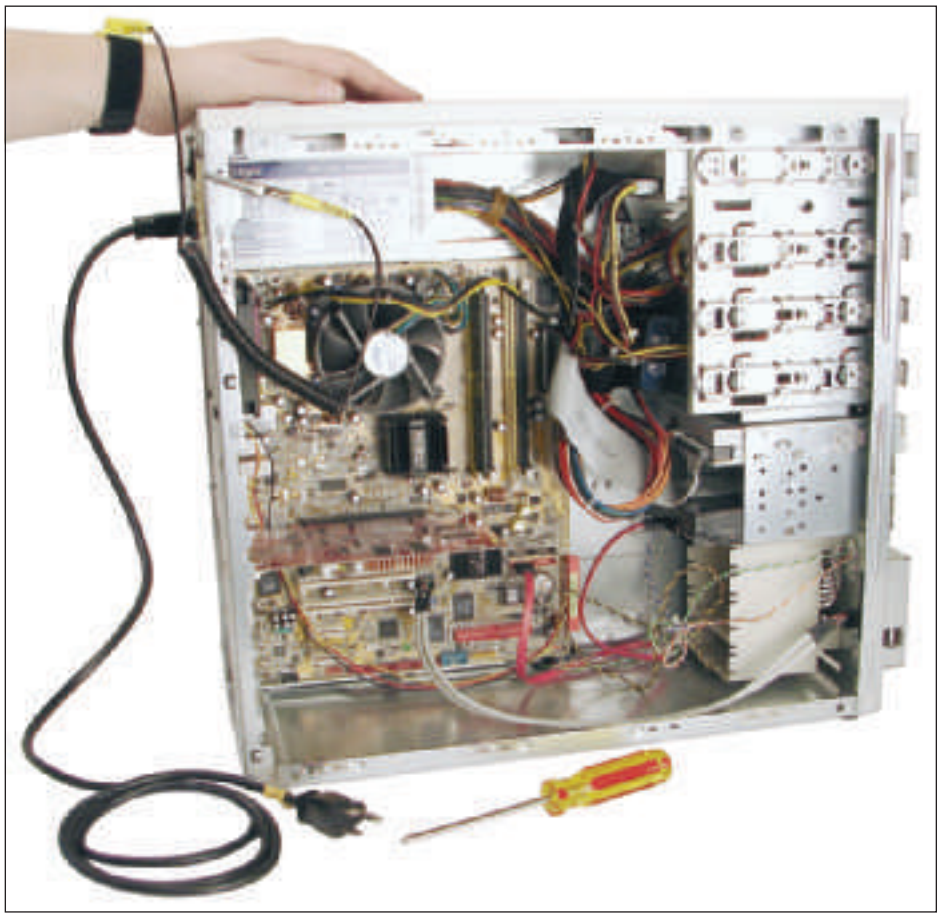

Figure 1-34 A ground bracelet, which protects computer components from ESD, can clip to the side of the computer case and eliminate ESD between you and the case

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- *Ground mats.* A **ground mat**, also called an **ESD mat**, dissipates ESD and is commonly used by bench technicians (also called depot technicians) who repair and assemble computers at their workbenches or in an assembly line. Ground mats have a connector in one corner that you can use to connect the mat to ground (see Figure 1-35). If you lift a component off the mat, it is no longer grounded and is susceptible to ESD, so it's important to use a ground bracelet with a ground mat.

Figure 1-35 A ground mat dissipates ESD and should be connected to ground

- *Static shielding bags.* New components come shipped in static shielding bags, also called **antistatic bags**. These bags are a type of Faraday cage, named after Michael Faraday, who built the first cage in 1836. A Faraday cage is any device that protects against an electromagnetic field. Save the bags to store other devices that are not currently installed in a PC. As you work on a computer, know that a device is not protected from ESD if you place it on top of the bag; the protection is inside the bag (see Figure 1-36).

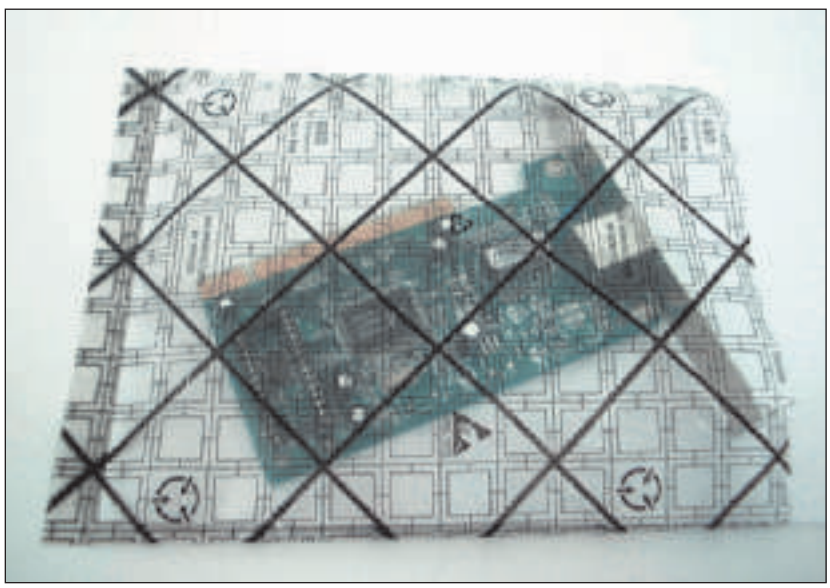

Figure 1-36 Static shielding bags help protect components from ESD

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- ***Antistatic gloves.*** Wear **antistatic gloves**, also called **ESD gloves**, designed to prevent an ESD discharge between you and a device as you pick it up and handle it (see Figure 1-37). The gloves can be substituted for an antistatic bracelet and are good for moving, packing, or unpacking sensitive equipment. Even through these gloves tend to get in the way when working inside computer cases, Intel recommends you wear them when handling a processor.

Figure 1-37 Use antistatic gloves to prevent static discharge between you and the equipment you are handling

Caution A CRT monitor can also damage components with ESD. Don't place or store expansion cards on top of or next to a CRT monitor, which can discharge as much as 29,000 volts onto the screen.

The best way to guard against ESD is to use a ground bracelet together with a ground mat or wear antistatic gloves. Consider a ground bracelet or antistatic gloves essential equipment when working on a computer. However, if you are in a situation in which you must work without one, touch the computer case or the power supply before you touch a component in the case, which is called **self-grounding**. Self-grounding dissipates any charge between you and whatever you touch. Here are some rules that can help protect computer parts against ESD:

- *Rule 1:* When passing a circuit board, memory module, or other sensitive component to another person, ground yourself and then touch the other person before you pass the component.
- *Rule 2:* Leave components inside their protective bags until you are ready to use them.
- *Rule 3:* Work on hard floors, not carpet, or use antistatic spray on the carpets.
- *Rule 4:* Don't work on a computer if you or the computer have just come in from the cold because there is more danger of ESD when the atmosphere is cold and dry.

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- *Rule 5:* When unpacking hardware or software, remove the packing tape and cellophane from the work area as soon as possible because these materials attract ESD.
- *Rule 6:* Keep components away from your hair and clothing.

A+ Exam Tip The A+ 220-801 exam emphasizes that you should know how to protect computer equipment as you work on it, including how to protect components against damage from ESD.

Hands-on Project 1-4 Practice Handling Computer Components

Working with a partner, you'll need some computer parts and the antistatic tools you learned about in this part of the chapter. Practice touching, picking up, and passing the parts between you. As you do so, follow the rules to protect the parts against ESD. Have a third person watch as you work and point out any ways you might have exposed a part to ESD. As you work, be careful to not touch components on circuit boards or the gold fingers on the edge connector of an expansion card. When you are finished, store the parts in antistatic bags.

Now that you know about electrical dangers and ways to protect you and the equipment, let's discuss the tools you need.

TOOLS USED BY A PC REPAIR TECHNICIAN

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Every PC repair technician needs a handy toolbox with a few essential tools. Several hardware and software tools can help you maintain a computer and diagnose and repair computer problems. The tools you choose depend on the amount of money you can spend and the level of PC support you expect to provide.

Essential tools for PC hardware troubleshooting are listed here, and several of them are shown in Figure 1-38. You can purchase some of these tools in a PC toolkit, although most PC toolkits contain items you really can do without.

Figure 1-38 Tools used by PC support technicians when maintaining, repairing, or upgrading computers

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Here is a list of essential tools:

- Ground bracelet, ground mat, or antistatic gloves to protect against ESD when working inside the computer case
- Flathead screwdriver
- Phillips-head or crosshead screwdriver
- Torx screwdriver set, particularly size T15
- Tweezers, preferably insulated ones, for picking pieces of paper out of printers or dropped screws out of tight places
- Extractor, a spring-loaded device that looks like a hypodermic needle (When you push down on the top, three wire prongs come out that can be used to pick up a screw that has fallen into a place where hands and fingers can't reach.)
- Software, including recovery CD or DVD for any OS you might work on (you might need several, depending on the OSs you support), antivirus software on bootable CDs or USB flash drives, and diagnostic software

The following tools might not be essential, but they are very convenient:

- Cans of compressed air (see Figure 1-39), small portable compressor, or antistatic vacuum cleaner to clean dust from inside a computer case
- Cleaning solutions and pads such as contact cleaner, monitor wipes, and cleaning solutions for CDs, DVDs, tapes, and drives
- Multimeter to check cables and the power supply output
- Power supply tester
- Needle-nose pliers for removing jumpers and for holding objects (especially those pesky nuts on cable connectors) in place while you screw them in
- Cable ties to tie cables up and out of the way inside a computer case
- Flashlight to see inside the computer case
- AC outlet ground tester
- Network cable tester (You will learn to use this tool in Chapter 15.)

Figure 1-39 A can of compressed air is handy to blow dust from a computer case

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- Loopback plugs to test ports
- Small cups or bags to help keep screws organized as you work
- Antistatic bags (a type of Faraday cage) to store unused parts
- Chip extractor to remove chips (To pry up the chip, a simple screwdriver is usually more effective, however.)
- Pen and paper for taking notes
- POST diagnostic cards

Keep your tools in a toolbox designated for PC troubleshooting. If you put discs and hardware tools in the same box, be sure to keep the discs inside a hard plastic case to protect them from scratches and dents. In addition, make sure the diagnostic and utility software you use is recommended for the hardware and software you are troubleshooting.

Now let's turn our attention to the details of several PC support technician tools, including diagnostic cards, power supply testers, and multimeters. Then we'll finish up the chapter with some additional safety procedures you need to be aware of.

POST DIAGNOSTIC CARDS

Although not an essential tool, a **POST diagnostic card**, also called a **POST card**, or motherboard test card, can be of great help to discover and report computer errors and conflicts that occur when you first turn on a computer and before the operating system (such as Windows 7) is launched. To understand what a POST card does, you need to know about the programs and data stored on the motherboard called the **BIOS (basic input/output system)**. Some adapter cards, such as a video card, also have BIOS programs embedded on the card.

The BIOS programs are stored on a special ROM (read-only memory) chip; because these embedded programs are so closely tied to the hardware, they are called **firmware**. Figure 1-40 shows an embedded firmware chip on a motherboard that contains the BIOS programs. When the computer is not receiving power, the firmware chip is powered by a battery nearby so it does not lose the data it holds in the memory on the chip, which is called CMOS RAM. CMOS RAM holds the motherboard configuration or settings and includes the computer date and time, power-on passwords, and which devices to look to when the BIOS is searching for an operating system (OS) to launch.

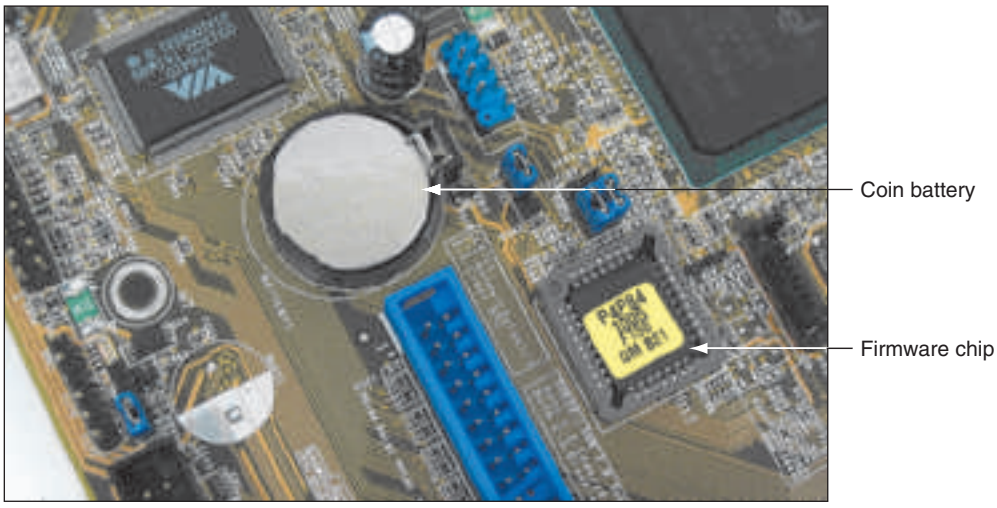

Figure 1-40 This firmware chip contains flash ROM and CMOS RAM; CMOS RAM is powered by the coin battery located near the chip

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The motherboard BIOS serves three purposes:

- **System BIOS** manages essential devices (such as the keyboard, mouse, hard drive, and monitor) before the OS is launched.
- **Startup BIOS** is used to start the computer.
- **BIOS setup** or **CMOS setup** is used to change the motherboard configuration or settings.

So now back to the usefulness of a POST card. The **POST (power-on self test)** is a series of tests performed by the startup BIOS when you first turn on a computer. These tests determine if startup BIOS can communicate correctly with essential hardware components required for a successful boot. If you have a problem that prevents the PC from booting that you suspect is related to hardware, you can install the POST card in an expansion slot on the motherboard and then attempt to boot. The card monitors the boot process and reports errors, usually as coded numbers on a small LED panel on the card. You then look up the number online or in the documentation that accompanies the card to get more information about the error and its source.

Examples of these cards are listed below. Some manufacturers make cards for either desktop or laptop computers. The Post Code Master card is shown in Figure 1-41.

- PC POST Diagnostic Test Card by Elston System, Inc. (*www.elstonsystems.com*)
- PCI POST Diagnostic Test Card by StarTech.com (*www.startech.com*)
- Post Code Master by Microsystems Development, Inc. (*www.postcodemaster.com*)

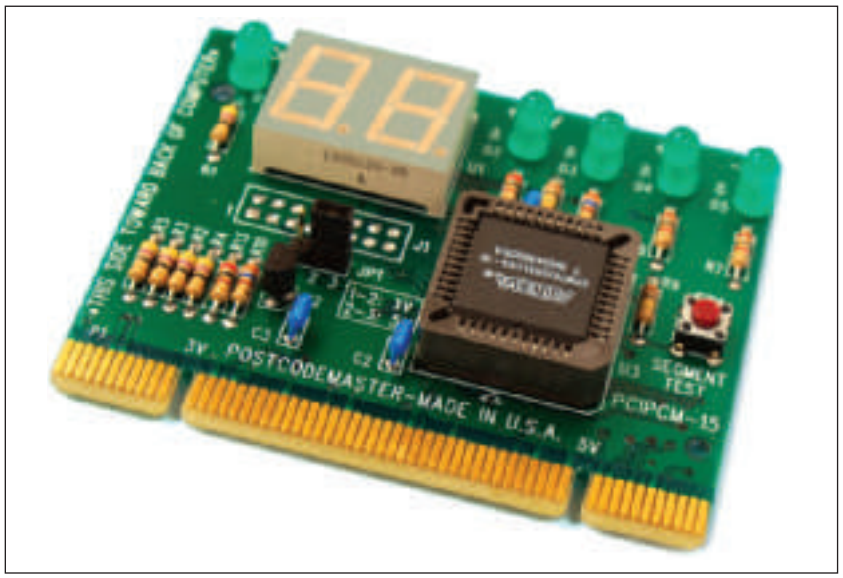

Figure 1-41 Post Code Master diagnostic card by Microsystems Developments, Inc. installs in a PCI slot

Before purchasing these or any other diagnostic tools or software, read the documentation about what they can and cannot do, and read some online product reviews. Try using Google.com and searching on "PC diagnostic card reviews."

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Notes Some Dell computers have lights on the case that blink in patterns to indicate a problem early in the boot before the OS loads. These blinking lights give information similar to that given by POST cards.

POWER SUPPLY TESTER

A **power supply tester** is used to measure the output of each connector coming from the power supply. You can test the power supply when it is outside or inside the case. As you saw earlier in Figure 1-8, the power supply provides several cables and connectors that power various components inside the computer case. A power supply tester has plugs for each type of cable. Connect a power cable to the tester, plug up the power supply, and turn on the tester. An LCD panel reports the output of each lead (see Figure 1-42). Later in the chapter, you learn about the various power supply cables and the voltages they supply.

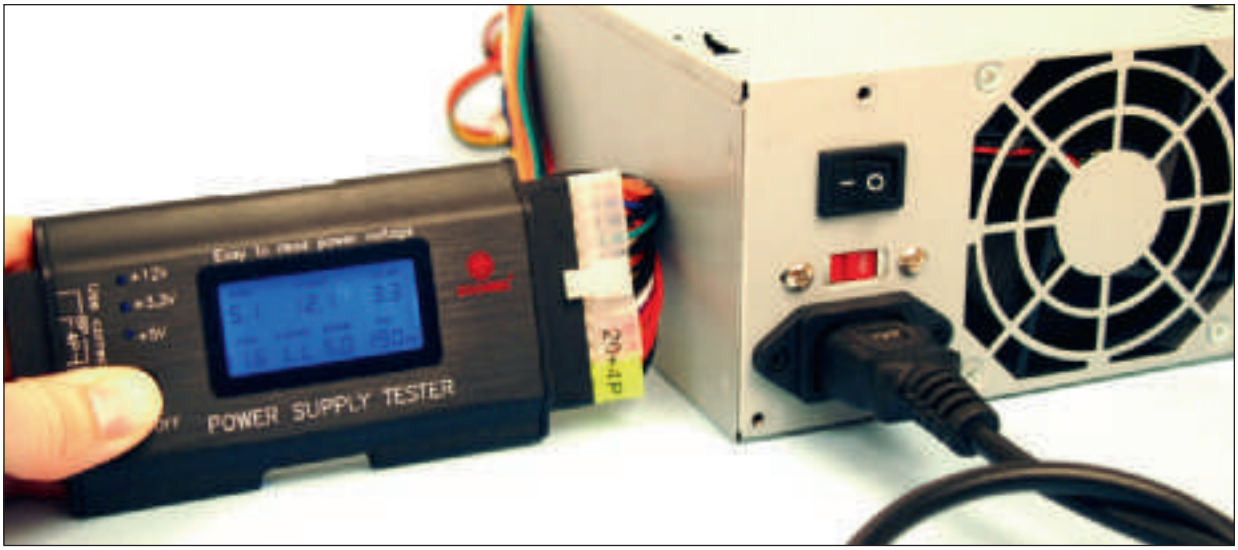

Figure 1-42 Use a power supply tester to test the output of each power connector on a power supply

MULTIMETER

A **multimeter** (see Figure 1-43) is a more general-purpose tool that can measure several characteristics of electricity in a variety of devices. Some multimeters can measure voltage, current, resistance, or continuity. (Continuity determines that two ends of a cable or fuse are connected without interruption.) When set to measure voltage, you can use it to measure output of each pin on a power supply connector. Set to measure continuity, a multimeter is useful to test fuses, to determine if a cable is good, or to match pins on one end of a cable to pins on the other end.

LOOPBACK PLUGS

A **loopback plug** is used to test a port in a computer or other device to make sure the port is working and might also test the throughput or speed of the port. Figure 1-44 shows a loopback plug testing a network port on a laptop. You know both the port and the network cable are good because the lights on either side of the port are lit. You can also buy a USB loopback plug to test USB ports.

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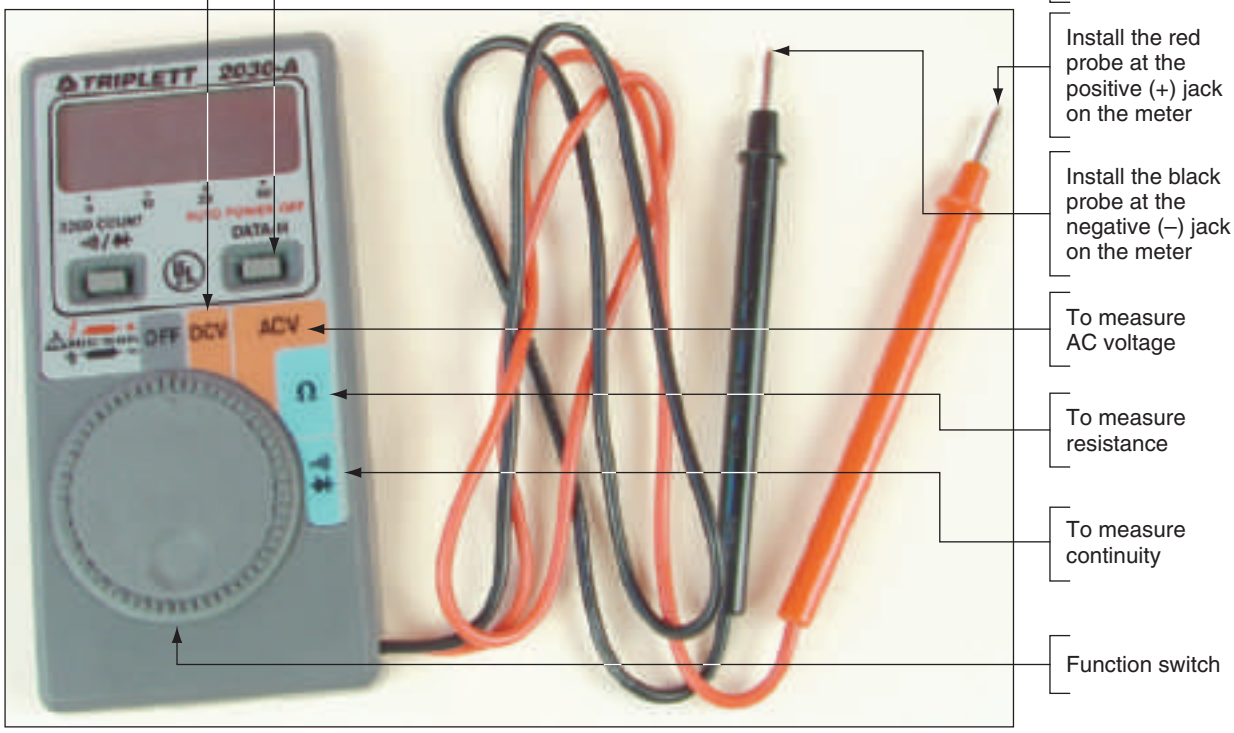

Figure 1-43 This digital multimeter can be set to measure voltage, resistance, or continuity

Figure 1-44 A loopback plug testing a network port and network cable

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PROPER USE OF CLEANING PADS AND SOLUTIONS

As a PC technician, you'll find yourself collecting different cleaning solutions and cleaning pads to clean a variety of devices, including the mouse and keyboard, CDs, DVDs, Blu-ray discs and their drives, tapes and tape drives, and CRT and LCD monitors. Figure 1-45 shows a few of these products. The contact cleaner in the figure is used to clean the contacts on the edge connectors of expansion cards; the cleaning can solve a problem with a faulty connection.

Figure 1-45 Cleaning solutions and pads

Most of these cleaning solutions contain flammable and poisonous materials. Take care when using them so that they don't get on your skin or in your eyes. To find out what to do if you are accidentally exposed to a dangerous solution, look on the instructions printed on the can or check out the material safety data sheet (see Figure 1-46). A **Material Safety Data Sheet (MSDS)** explains how to properly handle substances such as chemical solvents and how to dispose of them.

An MSDS includes information such as physical data, toxicity, health effects, first aid, storage, shipping, disposal, and spill procedures. It comes packaged with the chemical; you can order one from the manufacturer, or you can find one on the Internet (see *www.ilpi.com/msds*).

A+ Exam Tip The A+ 220-801 exam expects you to know how to use MSDS documentation to find out how to dispose of chemicals so as to help protect the environment. You also need to know that you must follow all local government regulations when disposing of chemicals and other materials dangerous to the environment.

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Figure 1-46 Each chemical you use should have available a material safety data sheet

If you have an accident with these or other dangerous products, your company or organization might require you to report the accident to your company and/or fill out an accident report. Check with your organization to find out how to handle reporting these types of incidents.

MANAGING CABLES

People can trip over cables or cords left on the floor, so be careful that cables are in a safe place. If you must run a cable across a path or where someone sits, use a cable or cord cover that can be nailed or screwed to the floor. Don't leave loose cables or cords in a traffic area where people can trip over them (called a **trip hazard**).

LIFTING HEAVY OBJECTS

Back injury, caused by lifting heavy objects, is one of the most common injuries that happen at work. Whenever possible, put heavy objects, such as a large laser printer, on a cart to move them. If you do need to lift a heavy object, follow these guidelines to keep from injuring your back:

1. Looking at the object, decide which side of the object to face so that the load is the most balanced.
2. Stand close to the object with your feet apart.
3. Keeping your back straight, bend your knees and grip the load.
4. Lift with your legs, arms, and shoulders, and not with your back or stomach.
5. Keep the load close to your body and avoid twisting your body while you're holding it.
6. To put the object down, keep your back as straight as you can and lower the object by bending your knees.

Don't try to lift an object that is too heavy for you. Because there are no exact guidelines for when heavy is too heavy, use your best judgment as to when to ask for help.

Now that you know about computer parts and their connections, the dangers and ways to protect you and the equipment against electricity, and the tools you need, you're ready to learn how to work inside a computer case. Have fun doing that in the next chapter, but don't forget to practice all the safety skills you learned about in this chapter.

>> CHAPTER SUMMARY

What's Inside the Case

- Video ports a computer might have include the VGA, S-Video, DVI, DisplayPort, and HDMI ports. Other ports include a network, sound, S/PDIF, USB, FireWire, eSATA, and PS/2 ports.
- Internal computer components include the motherboard, processor, expansion cards, memory modules, hard drive, optical drive, floppy drive, tape drive, and power supply.
- Form factors used by cases, power supplies, and motherboards are the ATX and micro-ATX form factors. The form factor determines how the case, power supply, and motherboard fit together and the cable connectors and other standards used by each.
- Power connectors used by the ATX and mini-ATX form factors include the 20-pin P1, 24-pin P1, 4-pin and 8-pin auxiliary motherboard, 4-pin Molex, 15-pin SATA, 4-pin FDD, 6-pin PCIe, and 8-pin PCIe connectors.
- Standards used by hard drives and other drives to interface with the motherboard and power supply are serial ATA (SATA) and parallel ATA (PATA). The PATA standard is also called the IDE standard.

Protecting Yourself and the Equipment against Electrical Dangers

- Units used to measure electricity include volts, amps, ohms, joules, and watts.
- Microcomputers require direct current (DC), which is converted from alternating current (AC) by the PC's power supply inside the computer case.
- A power supply and CRT monitor contain dangerous charges even when unplugged. PC support technicians consider them to be field replaceable units and you should not need to open one.
- Never use water to put out an electrical fire. Use a Class C fire extinguisher rated for electrical fires.
- Equipment to protect computer components against ESD includes a ground bracelet, ground mat, antistatic bags, and antistatic gloves.

Tools Used by a PC Repair Technician

- Special tools a PC support technician might need include a POST diagnostic card, power supply tester, multimeter, and loopback plugs.
- A Material Safety Data Sheet tells you how to handle chemicals and includes physical data, toxicity, health effects, first aid, storage, shipping, disposal, and spill procedures.
- Be careful to not lift a heavy object in a way you can hurt your back, and make sure cables are not trip hazards.

>> KEY TERMS

For explanations of key terms, see the Glossary near the end of the book.

A+ Exam Tip To help you prepare for the A+ exams, the key terms in each chapter focus on the terms you need to know for the exams. Before you sit for the exams, be sure to review all the key terms in the Glossary.

4-pin motherboard auxiliary connector
8-pin motherboard auxiliary connector
20-pin P1 connector
24-pin P1 connector
alternating current (AC)
amp
antistatic bags
antistatic gloves
antistatic wrist strap
ATX (Advanced Technology Extended)
ATX12V power supply
audio port
Berg power connector
BIOS (basic input/output system)
BIOS setup
central processing unit (CPU)
Class C fire extinguisher
CMOS setup
DB-15 port
desktop case
DIMM (dual inline memory module)
direct current (DC)
DisplayPort
dual voltage selector switch
DVI (Digital Video Interface) port
electrostatic discharge (ESD)
ESD gloves
ESD mat
ESD strap
Ethernet port
expansion card
external SATA (eSATA)
field replaceable unit (FRU)
FireWire port
firmware
floppy disk drive (FDD)
floppy drive
form factors
ground bracelet
ground mat
hard disk drive (HDD)
hard drive
HDMI (High Definition Multimedia Interface) port
heat sink
IEEE1394 port
internal components
inverter
joule
loopback plug
main board
Material Safety Data Sheet (MSDS)
microATX (MATX)
microprocessor
modem port
Molex power connector
motherboard
multimeter
network port
ohm
parallel ATA (PATA)
parallel port
PCI (Peripheral Component Interconnect)
PCI Express (PCIe)
PCIe power connector
POST (power-on self test)
POST card
POST diagnostic card
power supply
power supply tester
power supply unit (PSU)
processor
PS/2 port
RAM (random access memory)
RJ-11
RJ-45
rectifier
S-Video port
S/PDIF (Sony Philips Digital Interface) sound port
SATA power connector
self-grounding
serial ATA (SATA)
serial port
startup BIOS
static electricity
surge suppressor
system BIOS
system board
Thunderbolt
tower case
transformer
trip hazard
USB (Universal Serial Bus) port
VGA (Video Graphics Array) port
video memory
volt
watt

>> REVIEWING THE BASICS

1. Which is faster, a Hi-Speed USB port or a SuperSpeed USB port?
2. What type of output does an S/PDIF port provide?
3. List five types of video ports.

4. What is the purpose of an expansion slot on a motherboard?
5. What should be the setting for a dual-voltage selector switch on a power supply when using the computer in the United States?
6. What unit of measure is used to describe the amount of work a surge suppressor can do before it stops protecting the circuit from an electrical surge?
7. Hot wires in home wiring are normally colored ____, and ground wires in computers are normally colored _____.
8. What is the difference between a transformer and a rectifier? Which are found in a PC power supply?
9. What device can you use to make sure a computer is protected against power surges?
10. A power supply receives 120 volts of ___ power from a wall outlet and converts it to 3.3, 5, and 12 volts of ____ power.
11. Why is a power supply dangerous even after the power is disconnected?
12. Which two tools can a PC support technician use when taking apart a computer to best protect computer components against ESD?
13. What is the purpose of a POST diagnostic card?
14. What three purposes are accomplished by the motherboard BIOS?
15. What is the best way to determine if a cable inside a computer is a data and instruction cable or a power cable?
16. What technology standard provides for up to four drives installed in a system?
17. How many pins does the P1 connector have that uses the ATX Version 2.2 standard?
18. What device might require extra power so that it uses the 12V 6-pin power connector? In what two locations might you find the connector?
19. What is the purpose of the 4-pin auxiliary connector on a motherboard?
20. What is the purpose of the 4-pin Molex connector?

>> THINKING CRITICALLY

1. You purchase a new computer system that does not have wireless capability, and then you decide that you want to use a wireless connection to the Internet. What are the least expensive ways (pick two) to upgrade your system to wireless?
   a. Trade in the computer for another computer that has wireless installed.
   b. Purchase a second computer that has wireless.
   c. Purchase a wireless expansion card and install it in your system.
   d. Purchase a USB wireless adapter and connect it to your PC by way of a USB port.
2. How much power is consumed by a load drawing 5 A with 120 V across it?
3. When working on a computer, which of the following best protects against ESD? Why?
   a. Always touch the computer case before touching a circuit board inside the case.
   b. Always wear a ground bracelet clipped to the side of the case.

c. Always sit a computer on an antistatic mat when working on it.

d. Always work on a computer in a room without carpet.

4. When troubleshooting a computer hardware problem, which tool might help with each of the following problems?

a. You suspect the network port on a computer is not functioning.

b. The system fails at the beginning of the boot and nothing appears on the screen.

c. A hard drive is not working and you suspect the Molex power connector from the power supply might be the source of the problem.

>> REAL PROBLEMS, REAL SOLUTIONS

REAL PROBLEM 1-1: Planning Your PC Repair Tool Kit

Research on the web to find the following tools for sale: ground bracelet, antistatic gloves, set of flathead and Phillips-head screwdrivers, can of compressed air, monitor cleaning wipes, multimeter, power supply tester, cable ties, flashlight, loopback plug to test an Ethernet port, POST diagnostic card, and toolbox.

Print or save the web page showing each tool and its price. What is the total cost of this set of tools? If you were building your own PC repair tool kit, which tools would you purchase first if you could not afford the entire set of tools? Which tools not listed would you add to your toolbox?