Ch 1 = Taking a Computer Apart and Putting It Back Together

Module Introduction

Module Objectives

1. Disassemble and reassemble a desktop computer safely, and identify external ports and major components inside a desktop. Describe how they connect and are compatible. Identify various tools you will need as a computer hardware technician.
2. Disassemble and reassemble a laptop computer safely, and identify external ports and slots and major internal components. Understand special concerns when supporting and maintaining laptops.

Core 1

Certification Objectives

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

1.3 Given a scenario, set up and configure accessories and ports of mobile devices.

2.8 Given a scenario, use networking tools.

3.1 Explain basic cable types and their connectors, features, and purposes.

3.2 Given a scenario, install the appropriate RAM.

3.3 Given a scenario, select and install storage devices.

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

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

Introduction

Like many other computer users, you have probably used your personal computer to play games, check your email, write papers, or build Excel worksheets. This text takes you from being an end user of your computer to becoming an information technology (IT) support technician able to support all types of personal computers. 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 an IT support technician, you'll want to become A+ certified, which is the industry standard certification for IT support technicians. This text prepares you to pass the A+ 220-1101 Core 1 and 220-1102 Core 2 exams by CompTIA (comptia.org). The exams are required by CompTIA for A+ certification.

In this module, you take apart and reassemble a desktop computer and laptop while discovering the various hardware components inside the cases. You also learn about the tools you need to work inside the case.

Exam Tip

As you work your way through the modules and the appendix, notice the A+ Core 1 and Core 2 exam objective numbers that follow certain headings. This information identifies how the content maps to the exam objectives. In the text, A+ Core 1 objective numbers are tagged in teal, and A+ Core 2 objective numbers are tagged in orange. After studying each module or appendix, take a look at the grid at the beginning of this text, and make sure you understand each objective listed in the grid for the module or appendix just completed.

Taking apart and servicing a computer are tasks that every A+ certified technician needs to know how to do. As part of your preparation to become A+ certified, try to find old desktop and laptop computers you can take apart. If you can locate the service manual for a laptop, you should be able to take it apart, repair it (assuming the parts are still available and don't cost more than the computer is worth), and get it up and running again. Have fun with this module, and enjoy tinkering with these computers!

Exploring a Desktop Computer

Core 1 Objectives

- 1.1

  Given a scenario, install and configure laptop hardware and components.
- 2.8

  Given a scenario, use networking tools.
- 3.1

  Explain basic cable types and their connectors, features, and purposes.
- 3.2

  Given a scenario, install the appropriate RAM.
- 3.3

Given a scenario, select and install storage devices.

- 3.4

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

- 3.5

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

In this section of the module, you learn how to take apart a desktop computer and put it back together. This skill is needed in this module and others as you learn to add or replace computer parts inside the case and perhaps even build a system from scratch. As you read the following steps, you might want to refer to the Hands-On Projects at the end of the module, which allow you to follow along by taking a computer apart. As you do so, be sure to follow all the safety precautions found in the appendix "Safety Procedures and Environmental Concerns." In the steps that follow, each major computer component is identified and described. You learn much more about each component later in the text. Take your time—*don't rush*—as you take apart a computer for the first time. It can be a great learning experience or an expensive disaster! As you work, pay attention to the details and work with care.

Protecting Yourself and the Equipment

Core 1 Objectives

- 1.1

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

- 3.4

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

Protecting yourself and the equipment is essential for having a positive experience working inside a computer. When you follow the safety guidelines, you will be more likely to successfully complete your task and enjoy yourself while doing it. Remember to always ask your instructor for help if you have any questions about safety.

Follow these guidelines to protect yourself:

- Remove loose jewelry that might get caught in cables and components as you work.

- As you work, watch out for sharp edges on computer cases that can cut you.
- Consider the monitor and the power supply to be "black boxes." Never remove the cover or put your hands inside this equipment unless you know about the hazards of charged capacitors and have been trained to deal with them. The power supply and monitor contain enough power to kill you, even when they are unplugged.
- Power down the system and unplug it.
- For a computer, press and hold down the power button for three seconds to completely drain any residual power in the power supply.
- Never, ever touch the inside of a computer that is turned on. The one exception to this rule is when you're using a multimeter to measure voltage output.

Follow these guidelines to protect the equipment:

- Always wear an **ESD strap** (also called a ground bracelet, antistatic wrist strap, or ESD bracelet), which protects against electrostatic discharge when working inside the computer case. **Electrostatic discharge (ESD)** is another name for static electricity, which can damage chips and destroy motherboards, even though it might not be felt or seen with the naked eye. When you use the strap to connect or ground your hand to the case, as shown in Figure 1-1, any static electricity between you and the case is dissipated.

Figure 1-1

An ESD strap, which protects computer components from ESD, can clip to the side of the computer case and eliminate ESD between you and the case

- If an ESD strap is unavailable or won't work, use a **ground mat**, also called an **ESD mat**, to dissipate ESD (see Figure 1-2). While the equipment is resting on the ground mat, it is protected from ESD; however, if you lift the equipment off the mat, it is no longer protected, unless you are wearing an ESD strap.

Figure 1-2

An ESD mat dissipates ESD and should be connected to the ground

- Place equipment in a static shielding bag, also called an **antistatic bag**. These bags act as 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 antistatic bags as you find them, and use them whenever you take a piece of equipment out of a computer. Remember that a device that is set on top of an antistatic bag is not protected; it is only protected when it is placed inside the bag (see Figure 1-3).

Figure 1-3

An antistatic bag helps protect components from ESD

- Don't stack boards on top of each other. You could accidentally dislodge a chip this way. When you remove a circuit board or drive from a computer, carefully lay it on an antistatic mat or set it in an antistatic bag in a place where it won't get bumped.
- When handling motherboards, cards, or drives, don't touch the chips on the device. Hold expansion cards by the edges. Don't touch any soldered components on a card, and don't touch the edge connectors unless it's absolutely necessary. All this helps prevent damage from static electricity. Also, fingerprints on the edge connectors can cause later corrosion.
- To prevent damage to a microchip, don't touch it with a magnetized screwdriver.

Core to Core

It's important to know how to stay safe when working inside computers. Before opening a computer case and using the tools described in this section, be sure to read the appendix "Safety Procedures and Environmental Concerns." As you work inside a computer, follow all the safety guidelines discussed in that appendix.

Step 1: Planning and Organizing Your Work and Gathering Your Tools

Core 1 Objectives

- 2.8

  Given a scenario, use networking tools.

- 3.4

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

When you begin to learn how to work inside a computer case, make it a point to practice good organizational skills. If you keep your notes, tools, screws, and computer parts well organized, your work goes more smoothly and is more fun. Here are some tips to keep in mind:

- As you work, make notes using pencil and paper, and perhaps take photos with your cell phone so you can backtrack later if necessary. (When you're first learning to take a computer apart, it's easy to forget where everything fits when it's time to put the computer back together. Also, in troubleshooting, you want to avoid repeating actions or overlooking things to try.)
- To stay organized and avoid losing small parts, keep screws and spacers orderly and in one place, such as a cup or tray.
- In a classroom environment, after you have reassembled everything, have your instructor check your work before you put the cover back on and power up.

Tools Used by a Computer Hardware Technician

Every IT support technician who plans to repair desktop or laptop computers or mobile devices 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 hardware support you expect to provide.

Essential tools for computer hardware troubleshooting are listed here, and several of them are shown in Figure 1-4. You can purchase some of these tools in a computer toolkit, although most toolkits contain items you really can do without.

Figure 1-4

Tools used by IT support technicians when maintaining, repairing, or upgrading computers

Here is a list of essential tools:

- An ESD strap (also called a ground bracelet)
- 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
- Software, including recovery DVDs or USB recovery drives for any operating system (OS) you might work on (you might need several, depending on the OSs you support), antivirus software on bootable DVDs or USB flash drives, and diagnostic software

The following tools might not be essential, but they are very convenient to have on hand:

- Cans of compressed air (see Figure 1-5), small portable compressor, or antistatic vacuum cleaner to clean dust from inside a computer case

Figure 1-5

A can of compressed air is handy to blow dust from a computer case

- Cleaning solutions and pads such as contact cleaner, monitor wipes, and cleaning solutions for CDs and DVDs
- Multimeter to check cables and the power supply output
- Power supply tester
- POST diagnostic cards
- Needle-nose pliers for removing jumpers and for holding objects in place while you screw them in (especially handy for those pesky nuts on cable connectors)
- Cable ties to keep cables out of the way inside a computer case
- Flashlight to see inside the computer case
- AC outlet ground tester
- Network cable tester
- Loopback plugs to test ports
- Small cups or bags to help keep screws organized as you work
- Antistatic bags to store unused parts
- Pen and paper for taking notes

Keep your tools in a toolbox designated for hardware 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 that you've prepared your work area and tools, put on your ESD strap—let's get started with opening the computer case.

Step 2: Opening the Case

Core 1 Objectives

- 2.8

  Given a scenario, use networking tools.
- 3.1

  Explain basic cable types and their connectors, features, and purposes.
- 3.2

  Given a scenario, install the appropriate RAM.
- 3.3

  Given a scenario, select and install storage devices.
- 3.4

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

- 3.5

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

Before we discuss the parts inside a desktop case, let's take a quick look at the outside of the case and the ports and switches on it.

What's on the Outside of a Desktop Case

A computer case for any type of computer is sometimes called the **chassis**, and it 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 tablets. A **tower case** (see Figure 1-6) sits upright; it 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 desktop computer 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. Later in this module, you learn how to work inside a tower case, desktop case, laptop case, and all-in-one case.

Figure 1-6

This slimline tower case supports a microATX motherboard

Note 1

Don't lay a tower case on its side when the computer is in use because the CD or DVD drive might not work properly. For the same reason, if a desktop case is designed to lie flat, don't set it on its end when the computer is in use.

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

Table 1-1

Ports Used with Desktop and Laptop Computers

Port	Description
	A **VGA (Video Graphics Array) port**—also called a DB-15 port, **DB15 port**, **HD15 port**, or **DE15 port**—is a 15-pin, D-shaped, female port that transmits analog video. (**Analog** means a continuous signal with infinite variations as compared with **digital**, which is a series of binary values—1s and 0s.) All older monitors use VGA ports. (By the way, the HD15 [high-definition 15-pin] name for the port is an older name that distinguishes it from the early 9-pin VGA ports.)
	A **DVI (Digital Video Interface) port** transmits digital or analog video. You learn about the three types of DVI ports in the module "Supporting I/O Devices."
	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.
	A **DisplayPort** transmits digital video and audio (not analog transmissions) and is slowly replacing VGA and DVI ports on personal computers.
Source: Wikimedia Commons	A **Thunderbolt 3 port** transmits video, data, and power on the same port and cable and is popular with Apple computers. The port is shaped the same as the USB-C port and is compatible with USB-C devices. Up to six peripherals (for example, monitors and external hard drives daisy-chained together) can use the same Thunderbolt port.
	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. These types of audio ports can transmit analog or digital data. If you have one audio cable to connect to a speaker or earbuds, plug it into the lime green sound port in the middle of the three ports. The microphone uses the pink port.
	An **SPDIF (Sony-Philips Digital Interface) sound port** connects to an external home theater audio system, providing digital audio output and the best signal quality. SPDIF ports always carry digital audio and can work with electrical or optical cable. When connected to a fiber-optic cable, the port is called an **optical connector**.
	A **USB (Universal Serial Bus) port** is a multipurpose I/O port that comes in several sizes and is used by many different devices, including printers, mice, keyboards, scanners, external hard drives, and flash drives. Some USB ports are faster than others. There are several USB standards, with speeds consistently improving with each new release.
	An **external SATA (eSATA) port** is used by an external hard drive or other device using the eSATA interface.
	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 desktop, the purple port is for the keyboard, and the green port is for the mouse. Most newer computers use USB ports for the keyboard and mouse rather than the older PS/2 ports.
	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. Occasionally, you see a serial port on a router, where the port is used to connect the router to a device a technician can use to monitor and manage the router.
	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.

Port	Description
	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 1000 Mbps or 1 Gbps (gigabits per second). A megabit is one million bits, and a gigabit is one billion bits. A bit is a binary value of 1 or 0.

Exam Tip

The A+ Core 1 exam expects you to know how to identify the ports shown in Table 1-1.

Loopback Plugs

A **loopback plug** is used to test a network port in a computer or other device to make sure the port is working. It might also test the throughput or speed of the port. Figure 1-7 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.

Figure 1-7

A loopback plug testing a network port and network cable

What's Inside a Desktop Case

Now that you're familiar with the outside of the case, let's open the case to see what is inside. Here are the steps to open a computer case:

1. 1
   Back up important data. If you are starting with a working computer, make sure important data is backed up first. Copy the data to an external storage device such as a flash drive or external hard drive. If something goes wrong while you're working inside the computer, at least your data will be safe.
2. 2
   Power down the system and unplug it. Remove discs from the optical drive. Then power down the system, and unplug the power, monitor, mouse, and keyboard cables and any other peripherals or cables attached. Then move these cables out of your way.

Caution

When you power down a computer and even turn off the power switch on the rear of the computer case, residual power is still on. Some motherboards have a small light inside the case to remind you of this fact and to warn you that power is still getting to the system. Therefore, be sure to always unplug the power cord before opening a case.

3. 3

Press and hold down the power button for a moment. After you unplug the computer, press the power button for about three seconds to completely drain the power supply (see Figure 1-8). Sometimes when you do so, you'll hear the fans quickly start and go off as residual power is drained. Only then is it safe to work inside the case.

Figure 1-8

Press the power button after the computer is unplugged

4. 4
Have a plastic bag or cup handy to hold screws. When you reassemble the computer, you will need to insert the same screws in the same holes. This is especially important with the hard drive because screws that are too long can puncture the hard drive housing, so be careful to label those screws clearly.

5. 5
Open the case cover. Sometimes, figuring out how to open a computer case is the most difficult part of disassembling a computer. If you need help figuring it out, check the user manual or website of the case manufacturer. To remove the computer case cover, do the following:

- Some cases require you to start by laying the case on its side and removing the faceplate on the front of the case first. Other cases require you to remove a side panel first, and much older cases require you to first remove all the sides and top as a single unit. Study your case for the correct approach.
- Most cases have panels on each side that can be removed. It is usually necessary to remove only one panel to expose the top of the motherboard. To know which panel to remove, look at the port locations on the rear of the case. For example, in Figure 1-9, the ports on the motherboard are on the left side of the case, indicating the bottom of the motherboard is on the left. Therefore, you will want to remove the right panel to expose the top of the motherboard. Lay the case down to its left so the ports and the motherboard are on the bottom. Later, depending on how drives are installed, it might become necessary to remove the other side panel in order to remove the screws that hold the drives in place.

Figure 1-9

Decide which side panel to remove

- Locate the screws or clips that hold the side panel in place. Be careful not to unscrew any screws besides these. The other screws probably are holding the power supply, fan, and other components in place (see Figure 1-10). Place the screws in the cup or bag used for that purpose. Some cases use clips on a side panel in addition to or instead of screws (see Figure 1-11).

Figure 1-10

Locate the screws that hold the side panel in place

Figure 1-11

On this system, clips hold the side panel in place

- After the screws are removed, slide the panel toward the rear, and then lift it off the case (see Figure 1-12).

Figure 1-12

Slide the panel to the rear of the case

6. 6

Clip your ESD strap to the side of the computer case. To dissipate any charge between you and the computer, put on your ESD strap if you have not already done so. Then clip the alligator clip on the strap cable to the side of the computer case (see Figure 1-13).

Figure 1-13

Attach the alligator clip of your ground bracelet to the side of the computer case

After you open a computer case, as shown in Figure 1-14, the main components you see inside are the power supply, motherboard, expansion card, and drives installed in drive bays. You also see a lot of cables and wires connecting various components. These cables are power cables from the power supply to various components, or cables carrying data and instructions between components. The best way to know the purpose of a cable is to follow it from its source to its destination.

Figure 1-14

Inside the computer case 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 1-15 shows the top view of a motherboard, and Figure 1-16 shows the ports on the side of a motherboard.

Figure 1-15

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

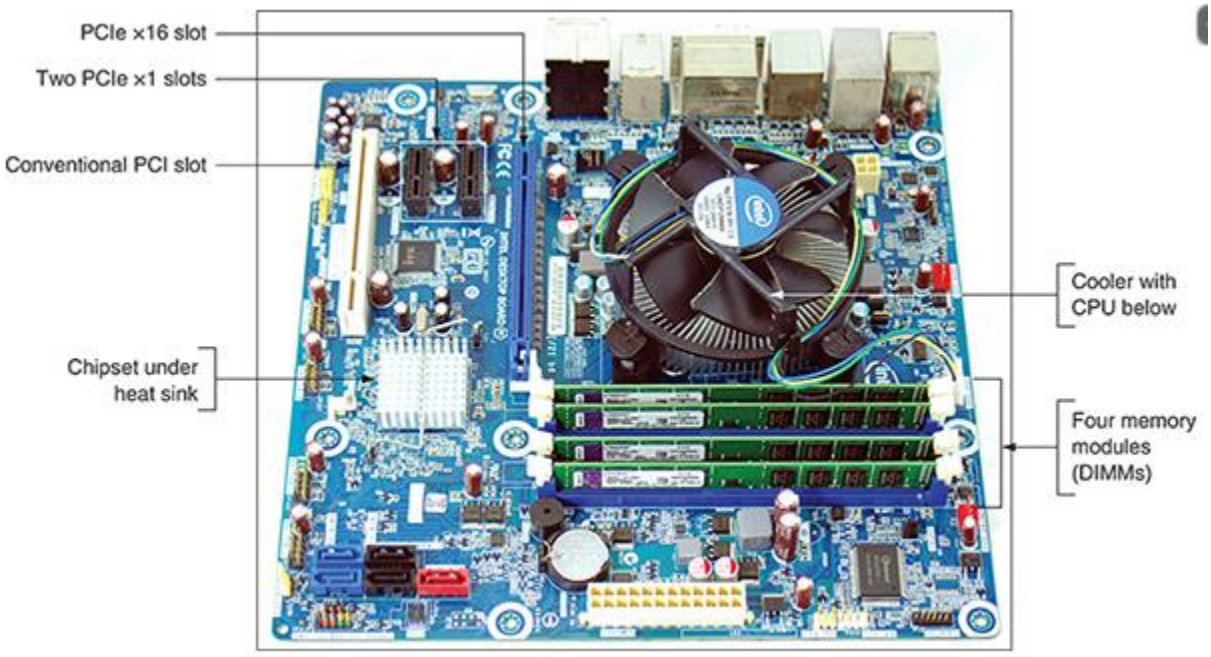
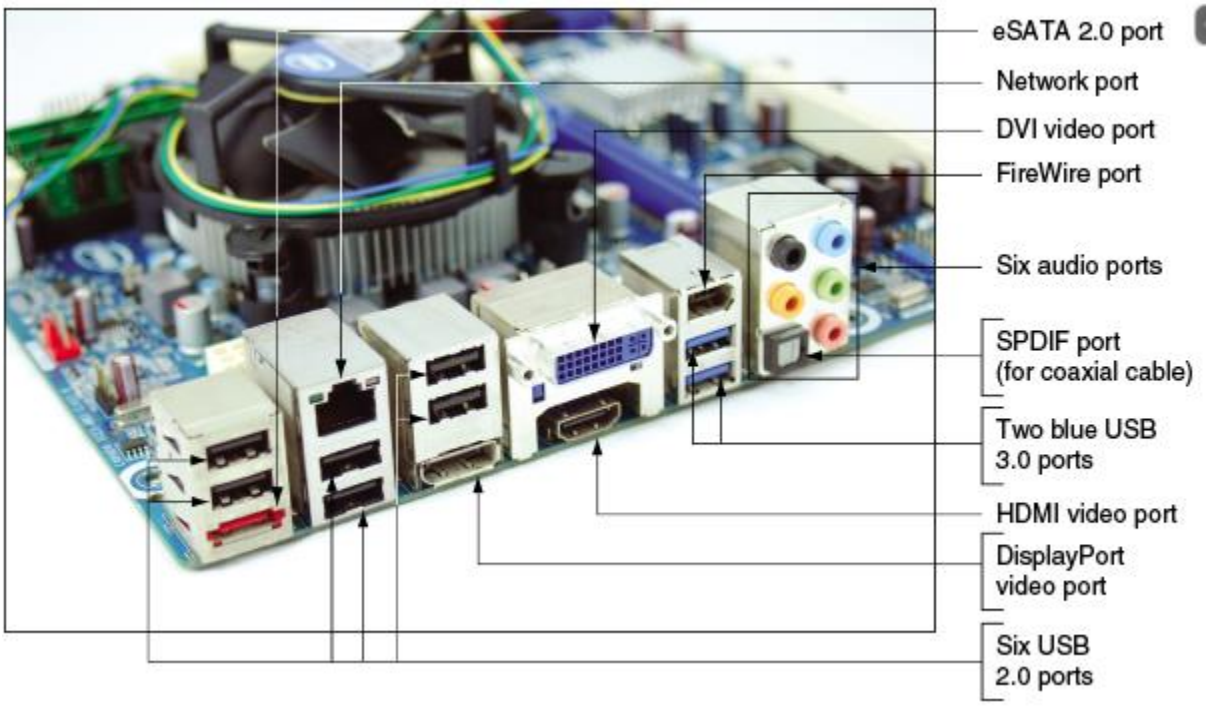


Figure 1-16

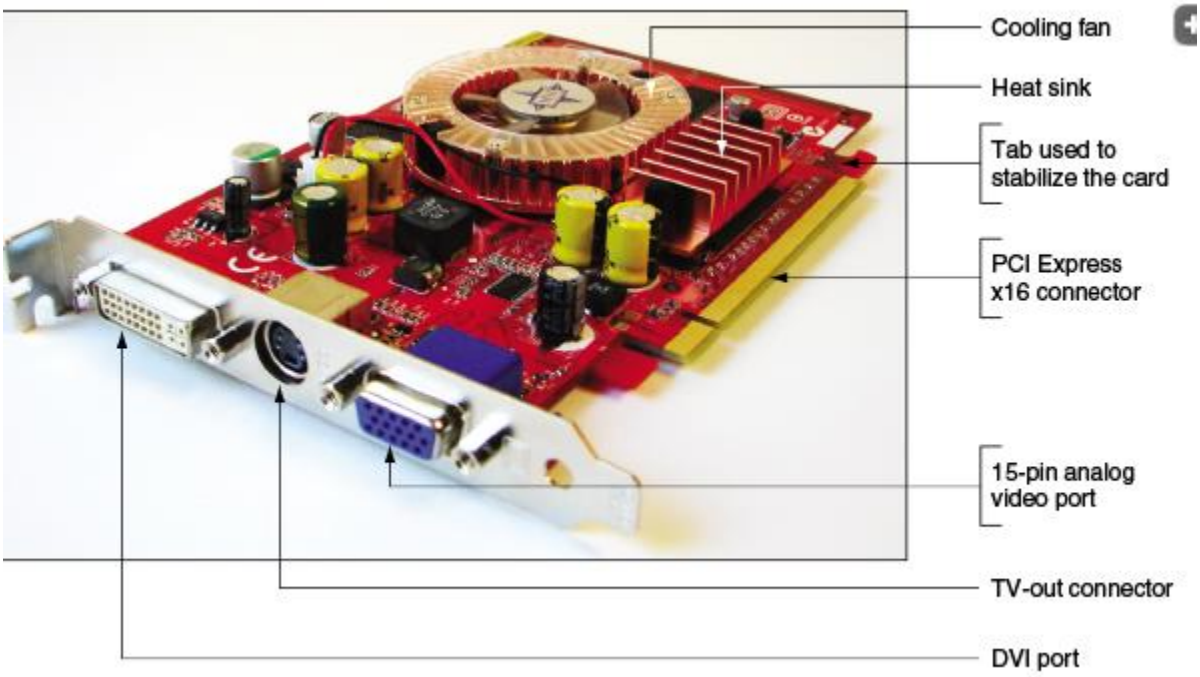
Ports provided by a motherboard



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 1-17 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), with decreased use of expansion cards.

Figure 1-17

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



- **Memory modules.** A desktop motherboard has memory slots, called **DIMM (dual inline memory module)** slots, to hold memory modules. Figure 1-18 shows a memory module installed in one DIMM slot along with 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 1-18 contains several RAM chips. Video cards also contain some embedded RAM chips for **video memory**.

Figure 1-18

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 and an optical drive. A **hard drive**, also called a **hard disk drive (HDD)**, is permanent storage used to hold data and programs.

For example, the Windows 10 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 1-14 has two hard drives and one optical drive installed. These three drives are also shown in Figure 1-19. The larger hard drive is a magnetic drive, and the smaller hard drive is a solid-state drive (SSD). 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 1-19

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

- **The 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 1-20) that receives and converts the house current so 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 if necessary—115 V is used in the United States, and 220 V is used in other countries. See Figure 1-21. The power cables can connect to and supply power to the motherboard, expansion cards, and drives.

Figure 1-20

A power supply with attached power cables

Figure 1-21

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

Note 2

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

Form Factors Used by Desktop Cases, Power Supplies, and Motherboards

The desktop 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 so you can anchor the board to the case. The holes in the case align with ports coming off the motherboard.
- 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 microATX form factors. Motherboards use these and other form factors that are compatible with ATX or microATX power supplies and cases. You learn about other motherboard form factors in the module "All About Motherboards." Following are important details about ATX and microATX:

- **ATX (Advanced Technology Extended)** is the most commonly used form factor today. It is an open, nonproprietary industry specification originally developed by Intel. An ATX power supply has a variety of power connectors (see Figure 1-22). The power connectors are listed in Table 1-2, and several of them are described next.

Figure 1-22

An ATX power supply with connectors

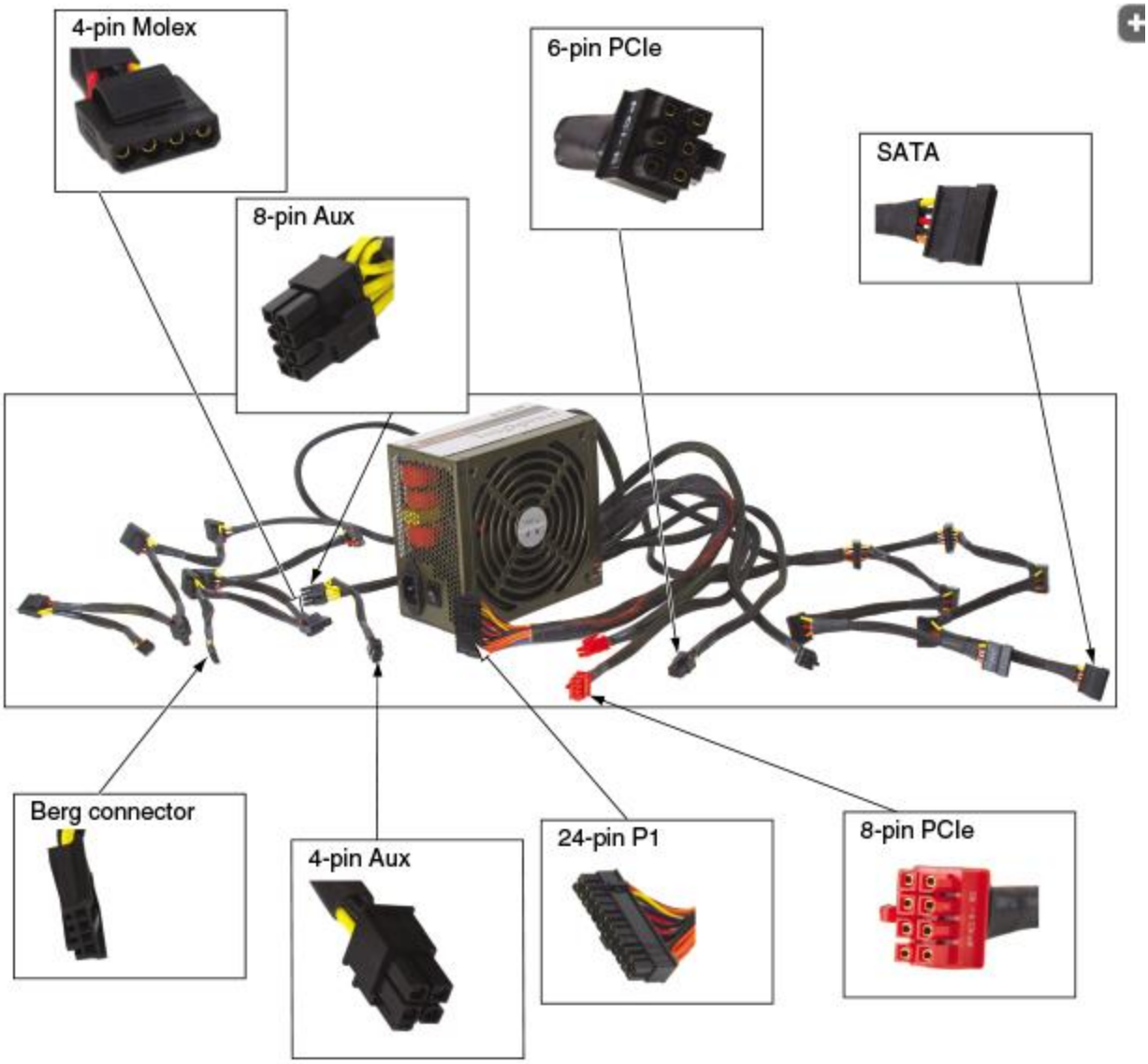


Table 1-2

Power Supply Connector

Connector	Description
	The **20-pin P1 connector** is the main motherboard power connector used in the early ATX systems.
	The **24-pin P1 connector**, also called the 20+4-pin connector, is the main motherboard power connector used today.
	The 20+4-pin P1 connector has four pins removed so the connector can fit into a 20-pin P1 motherboard connector.
	The **4-pin 12 V connector** is an auxiliary motherboard connector, which is used for extra 12 V power to the processor.

Connector	Description
	The **8-pin 12 V connector** is an auxiliary motherboard connector, which is used for extra 12 V power to the processor, providing more power than the older 4-pin auxiliary connector.
	The 4-pin **Molex connector** is used for older IDE drives and some newer SATA drives, and to provide extra power to video cards. It can provide +5 V and +12 V to the device.
	The 15-pin **SATA power connector** is used for SATA (Serial ATA) drives. It can provide +3.3 V, +5 V, and +12 V, although +3.3 V is seldom used.
	The PCIe 6-pin connector provides an extra +12 V for high-end video cards using PCI Express.
	The PCIe 8-pin connector provides an extra +12 V for high-end video cards using PCI Express.
	The **PCIe 6/8-pin connector** is used by high-end video cards using PCIe ×16 slots to provide extra voltage to the card; it can accommodate a 6-hole or 8-hole port. To make the 8-pin connector, combine both the 6-pin and 2-pin connectors.

Exam Tip

The A+ Core 1 exam expects you to know about each connector listed in Table 1-2 and to know how to choose a connector given a scenario.

Power connectors have evolved because components that use 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:

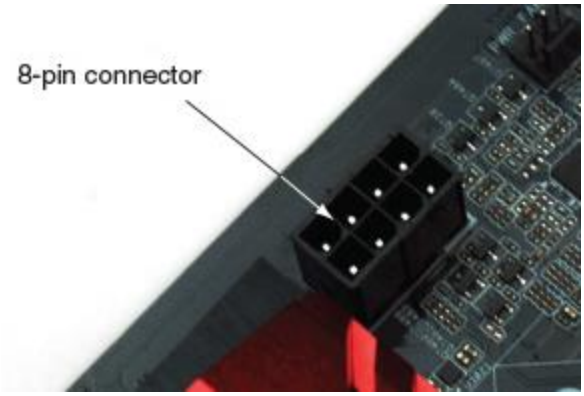
- **4-pin and 8-pin auxiliary connectors.** When processors began to require more power, the ATX Version 2.1 specifications added a 4-pin auxiliary connector near the processor socket to provide an additional 12 V of power (see Figure 1-23). A power supply that provides this 4-pin 12 V power cord is called an **ATX12V power supply**. Later boards replaced the 4-pin 12 V power connector with an 8-pin motherboard auxiliary connector that provided more amps for the processor. See Figure 1-24.

Figure 1-23

The 4-pin 12 V auxiliary power connector on a motherboard with a power cord connected

Figure 1-24

An 8-pin, 12 V auxiliary power connector for extra power to the processor



- **24-pin or 20+4-pin P1 connector.** The original P1 connector had 20 pins. 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.

  All motherboards today use a 24-pin P1 connector. The extra four pins on the 24-pin P1 connector provide +12 volts, +5 volts, and +3.3 volts. Figure 1-25 shows a 24-pin P1 power cord from the power supply and a 24-pin P1 connector on a motherboard. Figure 1-26 shows the pinouts for the 24-pin power cord connector, which is color-coded to wires from the power supply.

Figure 1-25

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

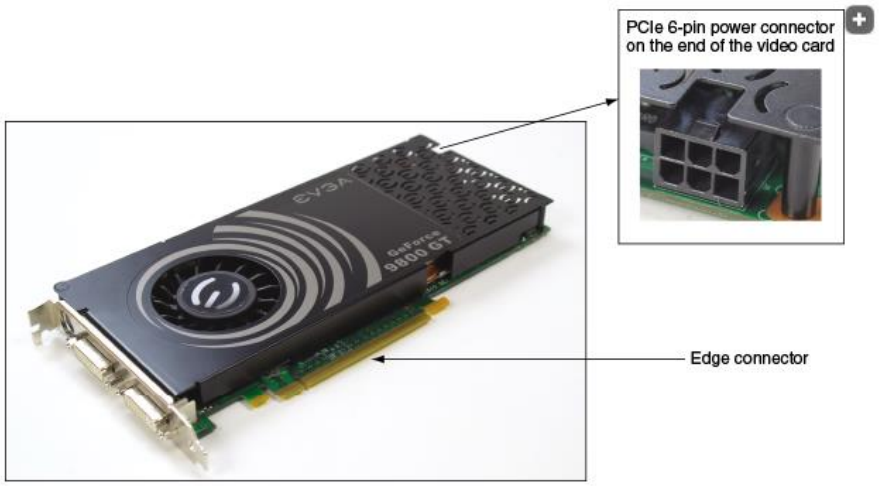
Figure 1-26

A P1 24-pin power connector follows ATX Version 2.2 and higher standards

- **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 and provide it more power than what comes through the PCIe slot on the motherboard. The PCIe power connector might have six or eight pins. Figure 1-27 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. The video card has a 6-pin connector on the end of the card. A PCIe 6-pin power cord from the power supply plugs into the connector. The power supply connector is shown earlier in Table 1-2.

Figure 1-27

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



- 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, which in turn reduces the power supplied to the board and allows for a smaller case size. A microATX motherboard (see Figure 1-28) 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.

Figure 1-28

This microATX motherboard by ASUS is designed to support an AMD processor

Exam Tip

The A+ Core 1 exam expects you to recognize and know the more important features of the ATX and microATX form factors used by power supplies. Given a scenario, you should be able to identify and choose the appropriate form factor.

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

Step 3: Removing Expansion Cards

Core 1 Objective

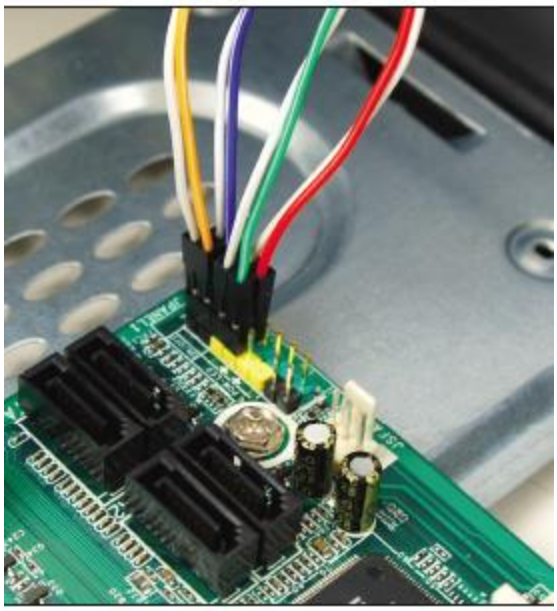
- 3.4

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

If you plan to remove several components, draw a diagram of all cable connections to the motherboard, expansion cards, and drives. You might need this cable connection diagram to help you reassemble. Note where each cable begins and ends, and pay particular attention to the small wires and connectors that connect the lights, switches, and ports on the front of the case to the motherboard front panel connectors. It's important to be careful about diagramming these because it is easy to connect them in the wrong position later when you reassemble. You can use a felt-tip marker to make a mark across components, which can indicate a cable connection, board placement, motherboard orientation, speaker connection, brackets, and so on. Then you can simply line up the marks when you reassemble. This method, however, probably won't work for the front case wires because they are so small. For these, consider writing down the colors of the wires and their positions on the pins or taking a photo of the wires in their positions with your cell phone (see Figure 1-29).

Figure 1-29

Diagram the pin locations of the color-coded wires that connect to the front of the case



Note 3

A header is a connector on a motherboard that consists of pins that stick up from the board. For example, the group of pins shown in Figure 1-29 is called the **front panel header**.

> Computer systems vary in so many ways that it's impossible to list the exact order to disassemble one. Most likely, however, you need to remove the expansion cards first. Do the following to remove the expansion cards:

1. 1
   Remove any wire or cable connected to the card.
2. 2
   Remove the screw holding the card to the case (see Figure 1-30).

   Figure 1-30

   Remove the screw holding the expansion card to the case
3. 3
   Grasp the card with both hands, and remove it by lifting straight up. If you have trouble removing it from the expansion slot, you can very slightly rock the card from end to end (not side to side). Rocking the card from side to side might spread the slot opening and weaken the connection.
4. 4
   As you remove the card, don't put your fingers on the edge connectors or touch a chip, and don't stack the cards on top of one another. Lay each card aside on a flat surface, preferably in an antistatic bag.

Note 4

Cards installed in PCI Express × 16 slots use a latch that helps to hold the card securely in the slot. To remove these cards, use one finger to hold the latch back from the slot, as shown in Figure 1-31, as you pull the card up and out of the slot.

Figure 1-31

Hold the retention mechanism back as you remove a video card from its expansion slot

Step 4: Removing the Motherboard

Core 1 Objective

- 3.4

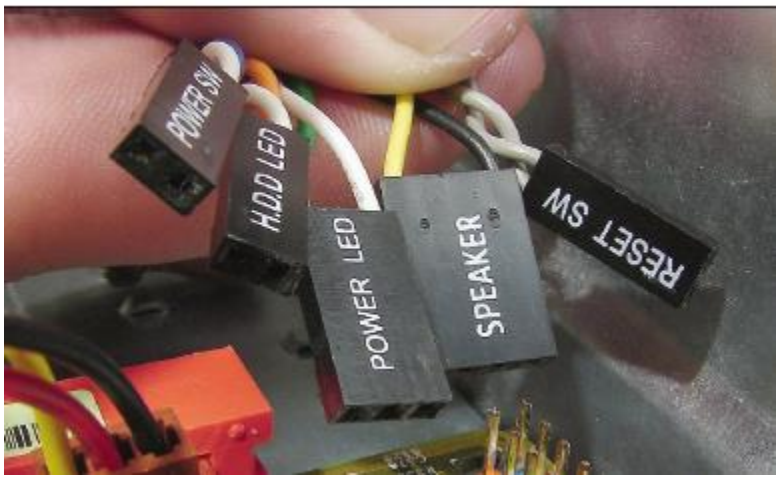
Given a scenario, install and configure motherboards, central processing units (CPUS), and add-on cards.

Depending on the system, you might need to remove the motherboard or the drives next. My choice is to first remove the motherboard. It and the processor are the most expensive and most easily damaged parts of the system. I like to get them out of harm's way before working with the drives. However, in some cases, you must remove the drives or the power supply before you can get to the motherboard. Study your situation and decide which to do first. To remove the motherboard, do the following:

1. 1
   Unplug the power supply lines to the motherboard.
2. 2
   Unplug SATA cables connected to the motherboard.
3. 3
   Disconnect the wires leading from the front or top of the computer case to the motherboard; these wires are called the **front panel connectors**. If you don't have the motherboard manual handy, be very careful to diagram how these wires connect because they are rarely labeled well on a motherboard. Make a careful diagram, and then disconnect the wires. Figure 1-32 shows five leads and the pins on the motherboard front panel header that receive these leads. The pins are color-coded and cryptically labeled on the board.

Figure 1-32

Five leads from the front panel connect to two rows of pins on the motherboard front panel header



4. 4
   Disconnect any other cables or wires connected to the motherboard. A case fan might be getting power by a small wire connected to the motherboard. In addition, USB ports on the front of the computer case might be connected by a cable to the motherboard.
5. 5
   You're now ready to remove the screws that hold the motherboard to the case. A motherboard is installed so that the bottom of the board does not touch the case. If the fine traces or lines on the bottom of the board were to touch the case, a short would result when the system runs again. To keep the board from touching the case, screw holes are elevated using **spacers**, also called **standoffs**, which are round plastic or metal pegs that separate the board from the case. Carefully pop off these spacers and/or remove the screws (up to nine) that hold the board to the case (see Figure 1-33) and then remove the board. Set it aside in a safe place.

Figure 1-33

Remove up to nine screws that hold the motherboard to the case

Figure 1-34 shows a motherboard sitting to the side of these spacers. Two spacers are in place, and the other is lying beside its case hole. In the figure, also notice the holes in the motherboard where screws are used to connect the board to the spacers.

Figure 1-34

This motherboard connects to a case using screws and spacers that keep the board from touching the case

Note 5

When you're replacing a motherboard that is not the same size as the original board in a case, you can use needle-nose pliers to unplug a standoff so you can move it to a new hole.

6. 6

The motherboard should now be free, and you can carefully remove it from the case, as shown in Figure 1-35. Lift the board by its edges, as shown in the figure.

Figure 1-35

Remove the motherboard from the case

Caution

Never lift a motherboard by the cooler because doing so might create an air gap between the cooler and the processor, which can cause the processor to overheat later.

Caution

Some processors have heavy or bulky cooling assemblies installed on top of them. For these systems, it is best to remove the cooler before you take the motherboard out of the case because the motherboard is not designed to support the heavy cooler when the motherboard is not securely seated in the case. Removal of the cooler is covered in the module "Supporting Processors and Upgrading Memory."

POST Diagnostic Cards

When supporting a motherboard, a **POST diagnostic card**, also called a **POST card** or motherboard test card, can be of great help in discovering and reporting computer errors and conflicts that occur after you first turn on a computer but before the operating system (such as Windows 10) is launched. To understand what a POST card does, you need to know about the **firmware**—the programs and data stored on the motherboard.

Firmware consists of the older **BIOS (basic input/output system)** firmware and the newer **UEFI (Unified Extensible Firmware**

Interface) firmware and is usually referred to as BIOS or UEFI. Figure 1-36 shows an embedded firmware chip on a motherboard that contains the BIOS/UEFI programs. BIOS/UEFI is responsible for managing essential devices (for example, keyboard, mouse, hard drive, and monitor) before the OS is launched, starting the computer, and managing motherboard settings. A feature of the newer UEFI is that it can manage a secure boot, assuring that no rogue malware or operating system hijacks the system during the boot.

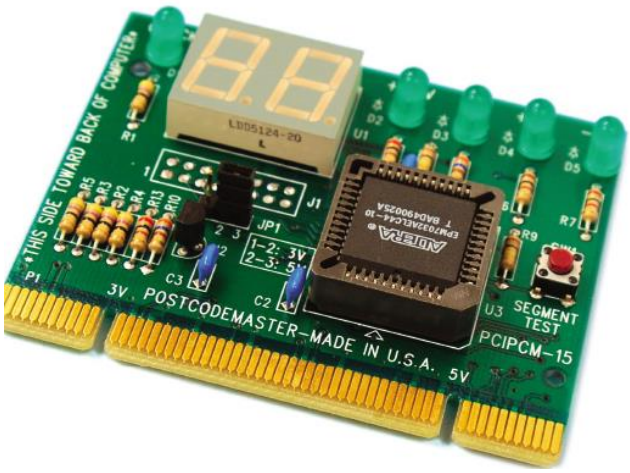
Figure 1-36

This firmware chip contains BIOS/UEFI, flash ROM, and CMOS RAM; CMOS RAM is powered by the coin battery located near the chip

A POST card is not essential, but it can be quite useful. The **POST (power-on self-test)** is a series of tests performed by the startup BIOS/UEFI when you first turn on a computer. These tests determine if the startup BIOS/UEFI can communicate correctly with essential hardware components required for a successful boot. If you have a problem that prevents the computer from booting and that you suspect is related to hardware, you can install the POST card in an expansion slot on the motherboard. For laptops, some cards install in a USB port. You can 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. Figure 1-37 shows a POST diagnostic card, the Post Code Master card by Microsystems Developments, Inc.

Figure 1-37

The Post Code Master diagnostic card by Microsystems Developments, Inc., installs in a PCI slot



Before purchasing this 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 "computer diagnostic card reviews."

Note 6

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.

Step 5: Removing the Power Supply

Core 1 Objective

- 3.5

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

To remove the power supply from the case, look for screws that attach the power supply to the computer case, as shown in Figure 1-38. Be careful not to remove any screws that hold the power supply housing together. You do not want to take the housing apart. After you have removed the screws, the power supply still might not be free. Sometimes, it is attached to the underside of the case by recessed slots. Turn the case over, and look on the bottom for these slots. If they are present, determine in which direction you need to slide the power supply to free it from the case.

Figure 1-38

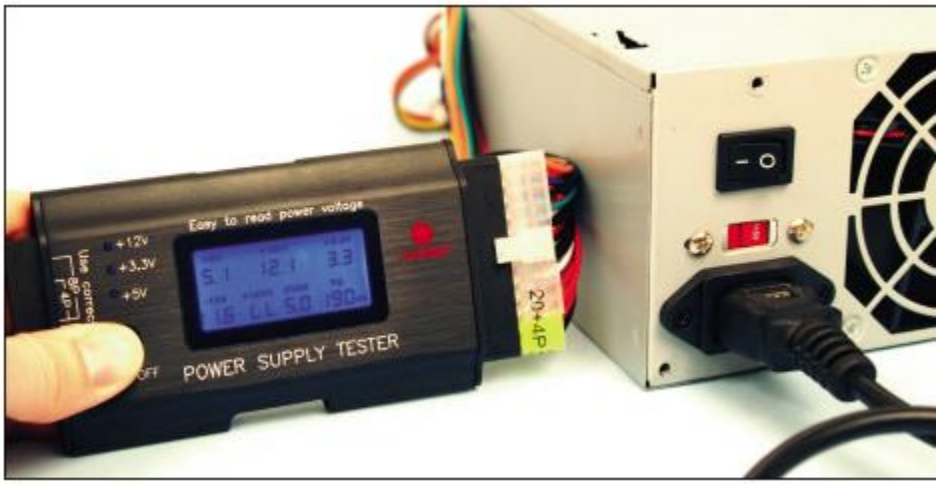
Remove the power supply mounting screws

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 1-20, 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 1-39).

Figure 1-39

Use a power supply tester to test the output of each power connector on a power supply

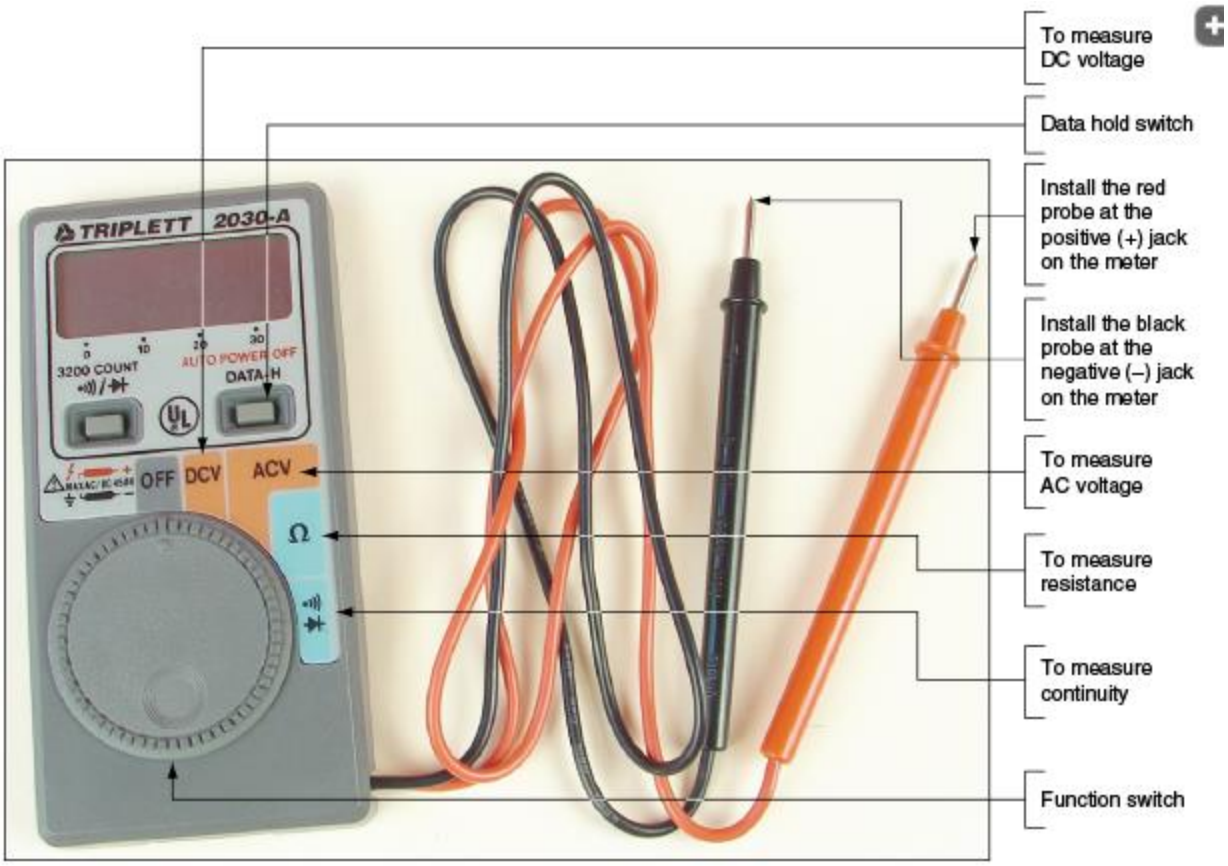


Multimeter

A **multimeter** (see Figure 1-40) 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, and 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. When 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.

Figure 1-40

This digital multimeter can be set to measure voltage, resistance, or continuity



Step 6: Removing the Drives

Core 1 Objective

- 3.3

Given a scenario, select and install storage devices.

A computer might have one or more hard drives, an optical drive (CD, DVD, or Blu-ray), 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. Most hard drives and optical drives today use the **serial ATA (SATA)** standard.

Figure 1-41 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 1-42). 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).

Figure 1-41

A hard drive subsystem using the SATA data cable

Figure 1-42

A SATA cable connects to a SATA connector in only one direction; for this system, use red connectors on the motherboard first

Remove each drive next, handling them with care. Here are some tips:

- Some drives have one or two screws on each side of the drive that attach the drive to the drive bay. After you remove the screws, the drive slides to the front or to the rear and then out of the case.
- Sometimes, there is a catch underneath the drive that you must lift up as you slide the drive forward.
- Some drive bays have a clipping mechanism to hold the drive in the bay. First release the clip, and then pull the drive forward and out of the bay (see Figure 1-43). Handle the drives with care. Some drives have an exposed circuit board on the bottom of the drive. Don't touch this board.

Figure 1-43

To remove this optical drive, first release the clip to release the drive from the bay

- Some drives must be removed through the front of the case, especially optical drives. After removing all screws or releasing the clipping mechanism, you might need to remove the front panel of the case to remove the drive. See Figure 1-44.

Figure 1-44

Some cases require you to remove the front panel before removing the optical drive

- Some cases have a removable bay for smaller hard drives (see Figure 1-45). The bay is removed first, and then the drives are removed from the bay. To remove the bay, first remove the screws or release the clip holding the bay in place, and then slide the bay out of the case. The drives are usually installed in the bay with two screws on each side of each drive. Remove the screws and then the drives (see Figure 1-46).

Figure 1-45

Push down on the clip, and then slide the removable bay forward and out of the case

Figure 1-46

Drives in this removable bay are held in place with screws on each side of the bay and drive

Steps to Put a Computer Back Together

Core 1 Objective

- 3.4

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

To reassemble a computer, reverse the process of disassembling. Here is where your diagrams will be especially useful; having the screws and cables organized will also help. In the directions that follow, we're also considering the possibility that you are installing a replacement part as you reassemble the system. Do the following:

1. 1
   Install components in the case in this order: power supply, drives, motherboard, and cards. When installing drives, know that for some systems, it's easier to connect data cables to the drives and then slide the drives into the bay. If the drive is anchored to the bay with screws or latches, be careful to align the front of the drive flush with the front of the case before installing screws or pushing in the latches (see Figure 1-47).

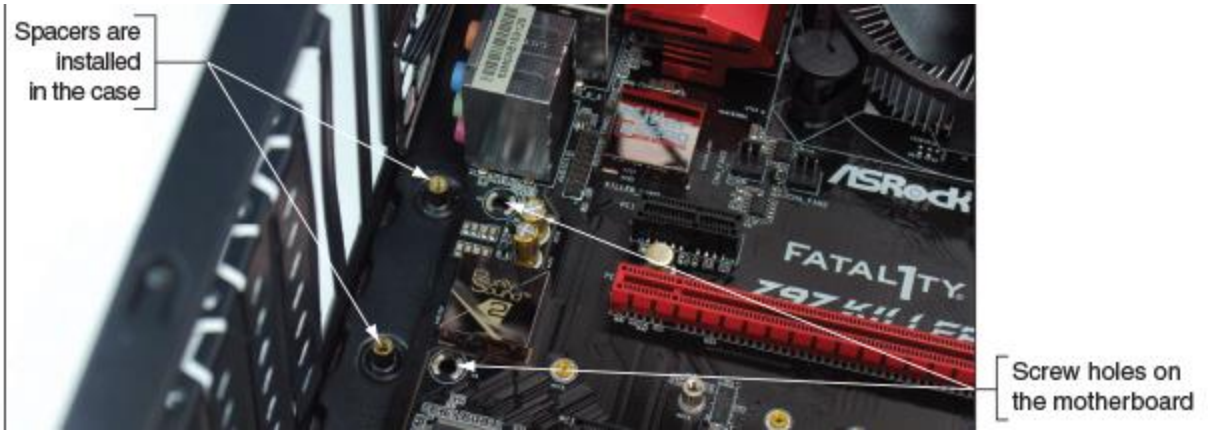
   Figure 1-47

   Align the front of the drive flush with the case front, and then anchor with a screw

2. 2
   Place the motherboard inside the case. Make sure the ports stick out of the I/O shield at the rear of the case and the screw holes line up with screw holes on the bottom of the case. Figure 1-48 shows how you must align the screw holes on the motherboard with those in the case. There should be at least six screw sets, and there might be as many as nine. Use as many screws as there are holes in the motherboard.

   Figure 1-48

   Align screw holes in the case with those on the motherboard



3. 3

Connect the power cords from the power supply to the motherboard. A system will always need the main P1 power connector and most likely will need the 4-pin auxiliary connector for the processor. Other power connectors might be needed depending on the devices you later install in the system. Here are the details:

- Connect the P1 power connector from the power supply to the motherboard (refer back to Figure 1-25).
- Connect the 4-pin or 8-pin auxiliary power cord from the power supply to the motherboard, as shown in Figure 1-49. This cord supplies the supplemental power required for the processor.

Figure 1-49

The auxiliary 4-pin power cord provides power to the processor

- To power the case fan, connect the power cord from the fan to pins on the motherboard labeled Fan Header. Alternately, some case fans use a 4-pin Molex connector that connects to a power cable coming directly from the power supply.
- If a CPU and cooler are already installed on the motherboard, connect the power cord from the CPU fan to the pins on the motherboard labeled CPU Fan Header.

4. 4

Connect the wire leads from the front panel of the case to the front panel header on the motherboard. These are the wires for the switches, lights, and ports on the front or top of the computer. Because your case and your motherboard might not have been made by the same manufacturer, you need to pay close attention to the source of the wires to determine where they connect on the motherboard. For example, Figure 1-50 shows a computer case that has seven connectors from the front panel that connect to the motherboard. Figure 1-51 shows the front panel header on the motherboard for these lights and switches. If you look closely at the board in Figure 1-51, you can see labels identifying the pins.

Figure 1-50

Seven connectors from the front panel connect to the motherboard

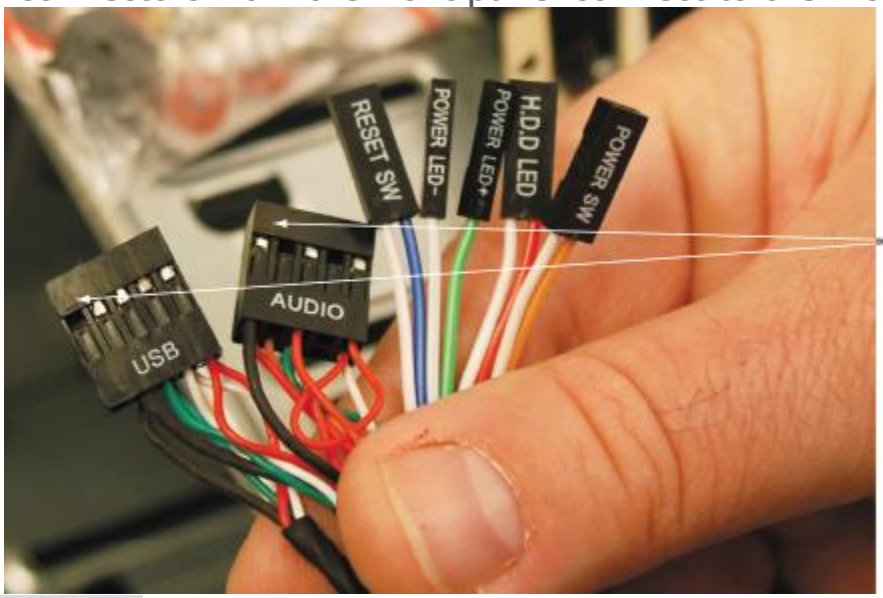
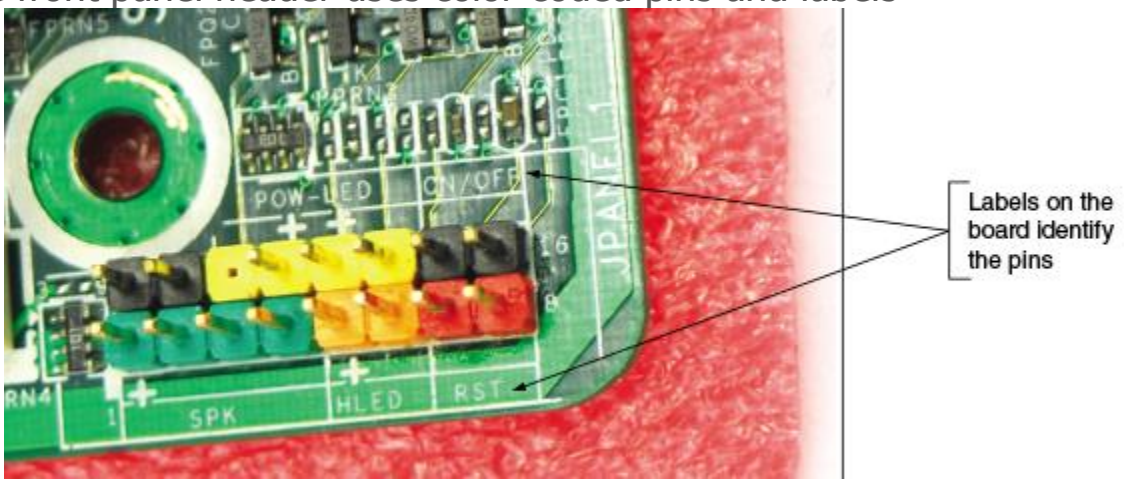


Figure 1-51

The front panel header uses color-coded pins and labels



The five smaller connectors on the right side of Figure 1-50 are labeled from right to left as follows:

- **Power SW.** Controls power to the motherboard; must be connected for the PC to power up

- **HDD LED.** Controls the drive activity light on the front panel that lights up when any SATA or IDE device is in use (HDD stands for hard disk drive and LED stands for light-emitting diode; an LED is a light on the front panel.)
- **Power LED+.** Controls the power light and indicates that power is on
- **Power LED–.** Controls the power light; the two positive and negative leads indicate that power is on
- **Reset SW.** Switch used to reboot the computer

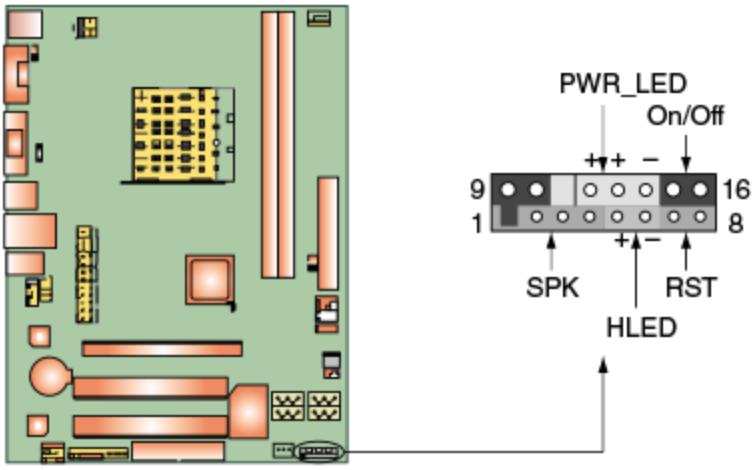
Note 7

Positive wires connecting the front panel to the motherboard are usually a solid color, and negative wires are usually white or striped.

> To help orient the larger connectors on the motherboard pins, look for a small triangle embedded on the connector that marks one of the outside wires as pin 1 (see Figure 1-50). Look for pin 1 to be labeled on the motherboard as a small 1 embedded to either the right or left of the group of pins. If the labels on the board are not clear, turn to the motherboard user guide for help. The diagram in Figure 1-52 shows what you can expect from one motherboard user guide. Notice pin 1 is identified as a square pin in the diagram, rather than round like the other pins.

Figure 1-52

Documentation for front panel header connections



Pin	Assignment	Function	Pin	Assignment	Function
1	+5 V	Speaker connector	9	N/A	N/A
2	N/A		10	N/A	
3	N/A		11	N/A	N/A
4	Speaker		12	Power LED (+)	Power LED
5	HDD LED (+)	Hard drive LED	13	Power LED (+)	
6	HDD LED (–)		14	Power LED (–)	
7	Ground	Reset button	15	Power button	Power-on button
8	Reset control		16	Ground	

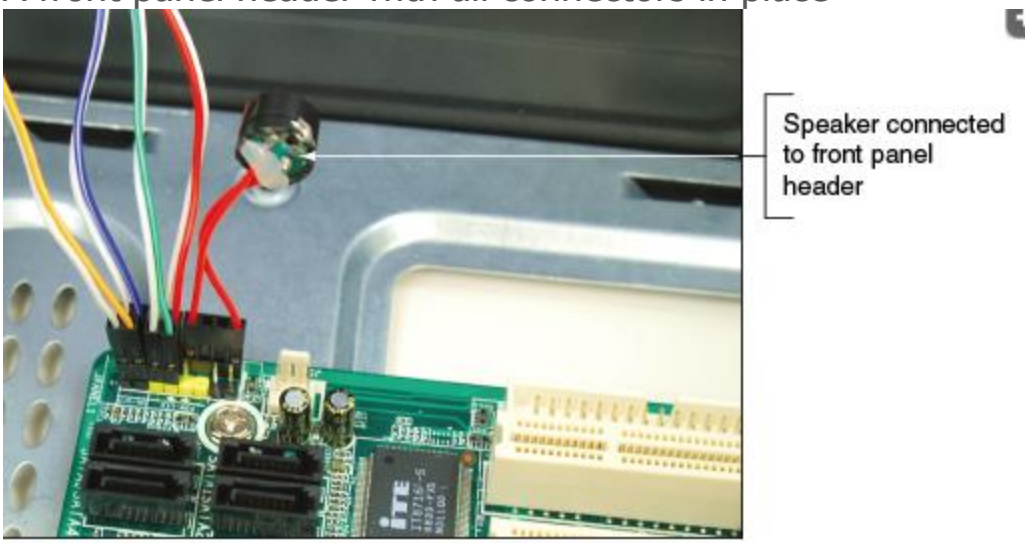
Note 8

If the user guide is not handy, you can download it from the motherboard manufacturer's website. Search on the brand and model number of the board, which is imprinted somewhere on the board.

> Sometimes the motherboard documentation is not clear, but guessing is okay when connecting a wire to a front panel header connection. If it doesn't work, no harm is done. Figure 1-53 shows all front panel wires in place and the little speaker also connected to the front panel header pins.

Figure 1-53

A front panel header with all connectors in place



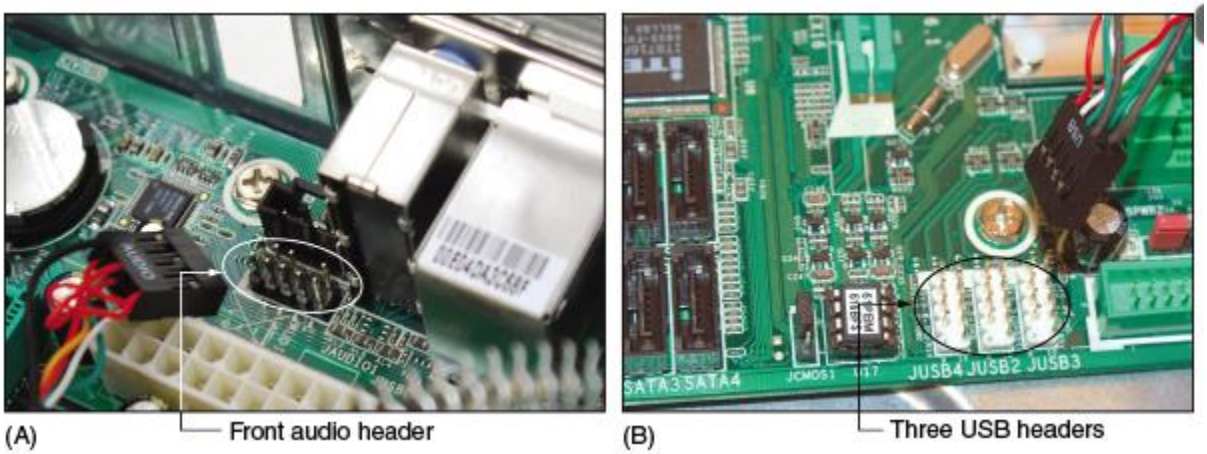
1. 5
   Connect wires to ports on the front panel of the case. Depending on your motherboard and case, there might be cables to connect audio ports or USB ports on the front of the case to headers on the motherboard. Audio and USB connectors are the two left connectors, previously shown in Figure 1-50. You can see these ports for audio and USB on the front of the case in Figure 1-54. Look in the motherboard documentation for the location of these connectors. The audio and USB connectors are labeled for one board in Figures 1-55A and 1-55B.

Figure 1-54

Ports on the front of the computer case

Figure 1-55

Connectors for front panel ports



2. 6
   Install the video card and any other expansion cards. Push the card straight down into the slot, being careful not to rock it side to side, and install the screw to secure the card to the case.

3. 7
   Take a few minutes to double-check each connection and make sure it is correct and snug. Verify that all required power cords are connected correctly and that the video card is seated solidly in its slot. Also verify that no wires or cables are obstructing fans. You can use cable ties to keep wires out of the way.

4. 8
   Plug in the keyboard, monitor, and mouse.

5. 9
   In a classroom environment, have the instructor check your work before you close the case and power up.

6. 10
   Turn on the power, and check that the PC is working properly. If the PC does not work, the problem is most likely a loose connection. Just turn off the power, and recheck each cable connection and each expansion card. You probably have not solidly seated a card in the slot. After you have double-checked, try again.

Now step back and congratulate yourself on a job well done! By taking a computer apart and putting it back together, you've learned how computer parts interconnect and work.

Now let's turn our attention to how to disassemble and reassemble a laptop.

First Look at Laptop Components

Core 1 Objectives

- 1.1

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

- 1.3

  Given a scenario, set up and configure accessories and ports of mobile devices.

A **laptop**, also called a **notebook**, is designed for portability (see Figures 1-56A and 1-56B) and can be just as powerful as a desktop computer. Nearly 75 percent of personal computers purchased today are laptops, and that percentage is growing. Laptops use the same technology as desktops, but with modifications to use less power, take up less space, and operate on the move.

Figure 1-56

A laptop, netbook, and all-in-one computer

iStock.com/Grassetto

Laptops come in several varieties, including some with a touch screen that allows you to handwrite on it with a stylus and some with a rotating or removable screen that allows you to use the laptop as a tablet (see Figure 1-57). Another variation of a laptop is a **netbook** (Figure 1-56B), which is smaller and less expensive than a laptop and has fewer features. An **all-in-one computer** (Figure 1-56C) has the monitor and computer case built together and uses components that are common to both a laptop and desktop. Because all-in-one computers use many laptop components and are serviced in similar ways, we include them in this part of the module.

Figure 1-57

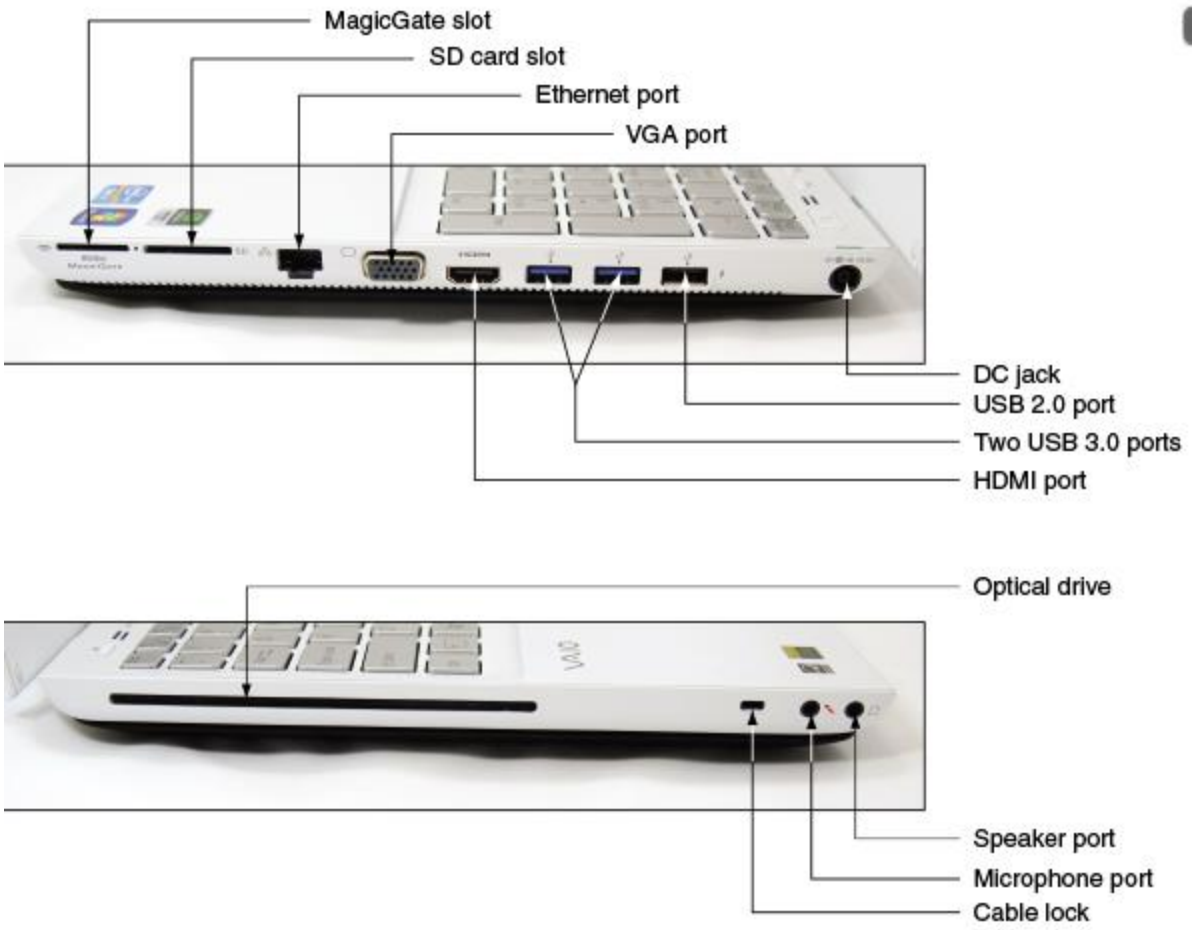
A laptop with a rotating screen can do double duty as a tablet computer

iStock.com/Rasslava

A laptop provides ports on its sides, back, or front for connecting peripherals (see Figure 1-58). Ports common to laptops as well as desktop systems include USB, network, and audio ports (for a microphone, headset, or external speakers). Video ports might include one or more VGA, DisplayPort, Thunderbolt (on Apple laptops), or HDMI ports to connect to a projector, second monitor, or television. On the side or back of the laptop, you'll see a DC jack to receive power from the AC adapter. A laptop may also have an optical drive, but netbooks usually don't have them.

Figure 1-58

Ports and slots on a laptop computer



Notice the two slots in Figure 1-58 used for flash memory cards: a MagicGate slot and an SD card slot. Each can support several types of flash memory cards, which you learn about later in the text.

When a laptop is missing a port or slot you need, you can usually find a USB dongle to provide the port or slot. Here are some possible solutions for a missing or failed port:

- **Connect to a local wired network.** Figure 1-59 shows a **USB to RJ-45 dongle**. Plug the dongle into a USB port, and plug a network cable into the RJ-45 port the dongle provides to connect the laptop to a wired network.

Figure 1-59

A USB to RJ-45 dongle provides a network port to connect to a wired network

Kensington Technology Group

- **Connect to a local wireless network.** Figure 1-60 shows a **USB to Wi-Fi dongle**, which allows you to connect a laptop that doesn't have wireless capability to a wireless network or when the laptop's wireless component has failed. **Wi-Fi (Wireless Fidelity)** is the common name for standards for a local wireless network.

Figure 1-60

This USB to Wi-Fi adapter plugs into a USB port to connect to a local wireless network

- **Connect to a cellular network.** Some laptops have embedded capability to connect to a cellular network. Figure 1-61 shows a USB cellular modem that can be used for a laptop that doesn't have the embedded technology. A **cellular network** consists of geographic areas of coverage called cells, each controlled by a tower called a **base station**. Cell phones are so named because they use a cellular network.

Figure 1-61

This USB device by Sierra Wireless provides a wireless connection to a cellular network

- **Connect to a Bluetooth device.** When a laptop doesn't have Bluetooth capability, you can use a **USB to Bluetooth adapter** to connect to a Bluetooth wireless device such as a Bluetooth printer, headphones, or smartphone. **Bluetooth** is a short-range wireless technology to connect two devices in a small personal network.
- **Use an external optical drive.** When a laptop or netbook doesn't have an optical drive, you can use a **USB optical drive**. Plug the USB optical drive into a USB port so you can use CDs and DVDs with the laptop or netbook.

Docking Stations and Port Replicators

Core 1 Objective

- 1.3

Given a scenario, set up and configure accessories and ports of mobile devices.

The bottom or sides of some laptops have a proprietary connector, called a **docking port** (see Figure 1-62), that connects to a docking station. A **docking station** provides ports to allow a laptop to easily connect to a full-sized monitor, keyboard, AC power adapter, and other peripheral devices. See Figure 1-63. Laptop manufacturers usually offer a docking station as an additional option on most business laptops and a few consumer laptops as well. A disadvantage of a docking station is that when you upgrade your laptop, you typically must purchase a new compatible docking station.

Figure 1-62

The docking port and sheet battery connector on the bottom of a laptop

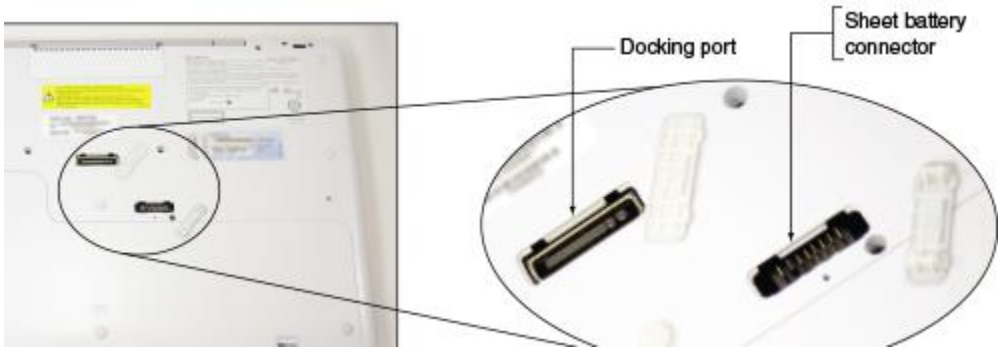


Figure 1-63

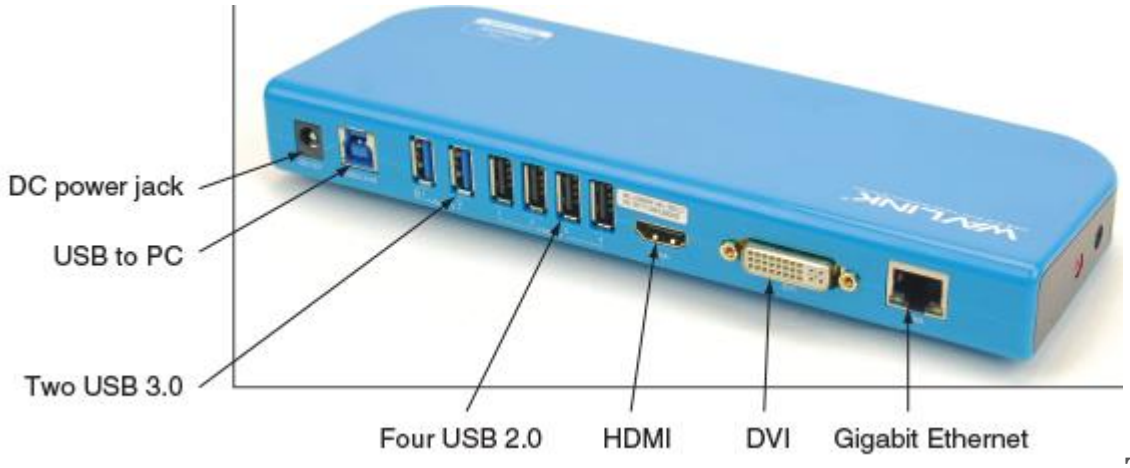
A docking station for a Lenovo ThinkPad

Source: Lenovo

A **port replicator**, sometimes called a universal docking station, is a device that provides ports to allow a laptop to easily connect to peripheral devices, such as an external monitor, network, printer, keyboard and mouse, or speakers. See Figure 1-64. Some port replicators also supply power to the laptop to charge the battery. The difference between a port replicator and a docking station is that a port replicator isn't proprietary to a single brand or model of laptop because it typically connects to a laptop using a single USB port.

Figure 1-64

This port replicator provides USB 3.0, USB 2.0, HDMI, DVI, and network ports



To use a docking station or port replicator, plug all the peripherals into the docking station or port replicator. Then connect your laptop to the station. No software needs to be installed. When you need to

travel with your laptop, you don't have to unplug all the peripherals; all you have to do is disconnect the laptop from the docking station or port replicator.

Special Considerations When Supporting Laptops

Core 1 Objectives

- 1.1

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

- 1.3

  Given a scenario, set up and configure accessories and ports of mobile devices.

Laptops and their replacement parts cost more than desktop computers with similar features because laptop components are designed to be more compact and stand up to movement. Laptops use compact hard drives, small memory modules, and CPUs that require less power than regular components. Whereas a desktop computer is often assembled from parts made by a variety of manufacturers, laptop computers are almost always sold by a vendor that either manufactured the laptop or had it manufactured as a consolidated system. Notable factors that generally apply more to laptop than desktop computers include the following:

- The original equipment manufacturer's warranty
- The service manuals and diagnostic software provided by the manufacturer
- The customized installation of the OS that is unique to laptops
- The need to order replacement parts directly from the laptop manufacturer or other source authorized by the manufacturer

In many situations, the tasks of maintaining, upgrading, and troubleshooting a laptop require the same skills, knowledge, and procedures as when servicing a desktop computer. However, you should take some special considerations into account when supporting, upgrading, and troubleshooting laptops. The same concerns apply to netbooks and all-in-one computers. Let's begin with warranty concerns.

Warranty Concerns

Most laptop manufacturers or retailers offer at least a one-year warranty and the option to purchase an extended warranty. If problems arise while the laptop is under warranty, you only have to deal with a single manufacturer or retailer to get support or parts. After the laptop is out of

warranty, this manufacturer or retailer can still be your one-stop shop for support and parts.

Caution

The warranty often applies to all components in the system, but it can be voided if someone other than an authorized service center representative services the laptop. Therefore, you as a service technician must be very careful not to void a warranty that the customer has purchased. Warranties can be voided by opening the case, removing part labels, installing other-vendor parts, upgrading the OS, or disassembling the system unless directly instructed to do so by authorized service center personnel.

Before you begin servicing a laptop, avoid potential problems with a warranty by always asking the customer, "Is the laptop under warranty?" If the laptop is under warranty, look at the documentation to find out how to get technical support. Options are online chat sessions, phone numbers, and email. Use the most appropriate option. Before you contact technical support, have the laptop model and serial number ready (see Figure 1-65). You'll also need the name, phone number, and address of the person or company that made the purchase. Consider asking the customer for a copy of the receipt and warranty so you'll have the information you need to talk with support personnel.

Figure 1-65

The model and serial number stamped on the bottom of a laptop are used to identify the laptop to service desk personnel

Based on the type of warranty purchased by the laptop's owner, the manufacturer might send an on-site service technician, ask you to ship or take the laptop to an authorized service center, or help you solve the problem by an online chat session or over the phone. Table 1-3 lists some popular manufacturers of laptops, netbooks, and all-in-ones. Manufacturers of laptops typically also produce all-in-ones because of the features they have in common.

Table 1-3

Laptop, Netbook, and All-in-One Manufacturers

Manufacturer	Website
Acer	acer.com and us.acer.com/support
Apple Computer	apple.com and support.apple.com
ASUS	asus.com and asus.com/us/support
Dell Computer	dell.com and dell.com/support

Manufacturer	Website
Hewlett Packard (HP)	hp.com and support.hp.com
Lenovo	lenovo.com and support.lenovo.com
Microsoft	microsoft.com and support.microsoft.com
Razer	razer.com and support.razer.com
Samsung	samsung.com and samsung.com/support
VAIO	us.vaio.com and support.us.vaio.com
Toshiba	toshiba.com and support.dynabook.com

Service Manuals and Other Sources of Information

Desktop computer cases tend to be similar to one another, and components in desktop systems are usually interchangeable among manufacturers. Not so with laptops. Laptop manufacturers typically take great liberty in creating their own unique computer cases, buses, cables, connectors, drives, circuit boards, fans, and even screws, all of which are likely to be proprietary in design.

Every laptop model has a unique case. Components are installed in unique ways, and opening the case for each laptop model is done differently. Because of these differences, servicing laptops can be very complicated, tedious, and time consuming. For example, a hard drive on one laptop is accessed by popping open a side panel and sliding the drive out of its bay. However, to access the hard drive on another model of laptop, you must remove the keyboard. If you are not familiar with a particular laptop model, you can damage the case frame or plastics as you pry and push while trying to open it. Using trial and error is likely to damage a case. Even though you might successfully replace a broken component, the damaged case will result in an unhappy customer.

Fortunately, a laptop service manual can save you considerable time and effort—if you can locate one online (see Figure 1-66). Most laptop manufacturers closely guard these service manuals and release them only to authorized service centers. Two laptop manufacturers, Lenovo and Dell, provide their service manuals online free of charge. ASUS and HP also do an excellent job of offering online support.

Figure 1-66

Download the laptop service manual to learn how to use diagnostic tools, troubleshoot a laptop, and replace components

For example, Figure 1-67 shows a screenshot from a video that walks through the steps to replace the top cover on an HP laptop. I applaud

Lenovo, Dell, and HP for their generous documentation about how their laptops are disassembled and for the options they provide for purchasing proprietary parts without first being an authorized service center.

Figure 1-67

The HP website (support.hp.com) provides detailed instructions and videos for troubleshooting and replacing components

Note 9

The wiki-type website ifixit.com does an excellent job of providing its own teardown and reassembly instructions for many brands and models of laptops. You can also buy parts and tools on the site.

Videos at youtube.com can also help teach you how to disassemble a specific model of laptop. However, be aware that not all videos posted on YouTube follow recommended best practices.

For all laptop manufacturers, check the Support or FAQ pages of their websites for help with tasks such as opening a case without damaging it and locating and replacing a component. Be aware that some manufacturers offer almost no help at all. Sometimes, you can find service manuals online. To find your manual, search on the laptop model—for example, search on "Lenovo ThinkPad L15 Gen 2 laptop service manual."

Don't forget about the user manuals. They might contain directions for upgrading and replacing components that do not require disassembling the case, such as how to upgrade memory or install a new hard drive. User manuals also include troubleshooting tips and procedures and possibly descriptions of BIOS/UEFI settings. In addition, you can use a web search engine to search on the computer model, component, or error message, which might give you information about the problem and solution.

Diagnostic Tools Provided by Manufacturers

Most laptop manufacturers provide diagnostic software that can help you test components to determine which component needs replacing. As one of the first steps when servicing a laptop, check the user manual, service manual, or manufacturer's website to determine if diagnostic software exists and how to use it. Use the software to pinpoint the problem component, which can then be replaced.

Check the manufacturer's website for diagnostics software that can be downloaded for a specific model of laptop or stored on the hard drive or on CDs bundled with the laptop. Figure 1-68 shows a window provided by the diagnostics program installed on the hard drive of one laptop.

Figure 1-68

Use diagnostics software provided by a laptop manufacturer to troubleshoot hardware problems

Note 10

When you purchase a replacement part for a laptop from the laptop's manufacturer, most often the manufacturer also sends detailed instructions for exchanging the part and/or phone support to talk you through the process.

One example of diagnostic software is PC-Doctor (pc-doctor.com), which is recommended by some manufacturers. The diagnostic software is stored on the hard drive or on CD. If stored on CD, you can boot from the CD to run the tests. If the software is stored on the hard drive, you can run it from the Windows Start menu or by pressing a function key at startup before Windows loads. Either way, PC-Doctor can run tests on the keyboard, video, speakers, touch pad, optical drive, wireless LAN, motherboard, processor, ports, hard drive, and memory. To learn how to use the software, see the laptop's service manual or user manual. You can find a stand-alone version of PC-Doctor for DOS and PC-Doctor for Windows at pc-doctor.com. You can purchase it at this site; it's expensive but might be worth it if you plan to service many laptops.

Working Inside a Laptop Computer

Core 1 Objective

- 1.1

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

Sometimes it is necessary to open a laptop case so you can upgrade memory, exchange a hard drive, or replace a failed component such as the keyboard, Mini PCIe card, or wireless card. Most laptops sold today are designed so that you can easily purchase and exchange memory modules or hard drives. However, replacing a failing processor or motherboard can be a complex process, taking several hours. Most often, you will choose to replace the entire laptop rather than doing these labor-intensive and costly repairs.

Screws and nuts on a laptop are smaller than those on a desktop system, requiring smaller tools. Figure 1-69 shows several tools used to disassemble a laptop, although you can get by without several of them. Here's the list:

- ESD strap

- Small flathead screwdriver
- Number 1 Phillips-head screwdriver
- Metal and plastic **spudgers** in various sizes (useful for prying open casings without damaging plastic connectors and cases, such as the one in Figure 1-67)
- Dental picks and tweezers (useful for prying without damaging plastic cases, connectors, and screw covers, such as the one in Figure 1-70)
- Torx screwdriver set, particularly size T5
- Something such as a pillbox to keep screws and small parts organized
- Notepad for note-taking or digital camera (optional)
- Flashlight (optional)

Figure 1-69

Tools for disassembling a laptop

Figure 1-70

Use a small screwdriver or dental pick to pry up the plastic cover hiding a screw

Working on laptops requires extra patience. As with desktop systems, before opening the case of a laptop or touching sensitive components, you should always wear an ESD strap to protect the system against ESD. You can attach the alligator clip end of the strap to an unpainted metallic surface on the laptop. This surface could be, for instance, a port on the back of the laptop (see Figure 1-71). If a ground strap is not available, first dissipate any ESD between you and the laptop by touching a metallic, unpainted part of it, such as a port on the back, before you touch a component inside the case.

Figure 1-71

To protect the system against ESD, attach the alligator clip of a ground strap to an I/O port on the back of the laptop

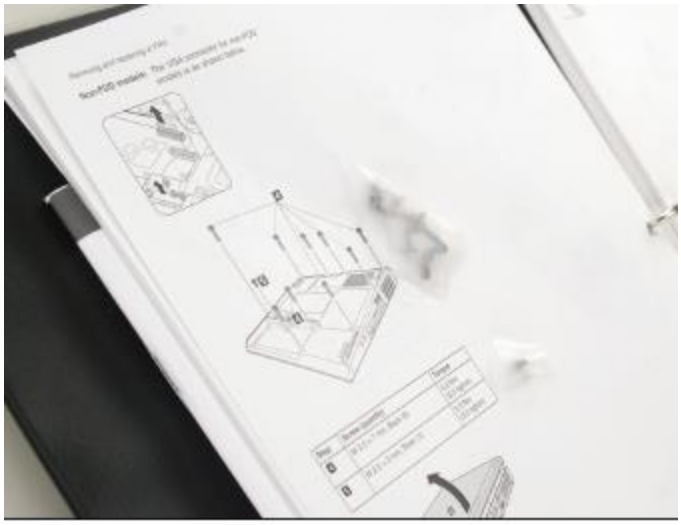
Laptops contain many small screws of various sizes and lengths. When reassembling the system, put screws back where they came from so you won't use screws that are too long and that can protrude into a sensitive component and damage it. As you remove a screw, store or label it so you know where it goes when reassembling. One method is to place screws in a pillbox with each compartment labeled. Another way is to place screws on a soft, padded work surface and use white labeling tape to label each set of screws. A third way to organize screws is to put them on notebook paper and write beside them where the screw belongs (see Figure 1-72). My favorite method of keeping up with all these screws is to tape each one beside the manufacturer documentation that I'm following to disassemble the laptop (see Figure 1-73). Whatever method you use, work methodically to keep screws and components organized so you know what goes where when reassembling.

Figure 1-72

Using a notepad can help you organize screws so you know which screw goes where when reassembling

Figure 1-73

Tape screws beside the step in the manufacturer documentation that told you to remove the screw



Exam Tip

The A+ Core 1 exam expects you to know the importance of keeping parts organized when disassembling a laptop as well as the importance of having manufacturer documentation to know the steps for disassembly. Given a scenario, you should be able to adhere to appropriate procedures.

If you disassemble a computer and are not following directions from a service manual, keep notes as you work to help you reassemble later. Draw diagrams and label things carefully. Include cable orientations and screw locations in your drawings. You might consider using a digital camera. Photos taken at each step in the disassembly process will be a great help when it's time to put the laptop back together.

When disassembling a laptop, consider the following tips:

- Make your best effort to find the hardware service manual for the particular laptop model you are servicing. The manual should include all the detailed steps to disassemble the laptop and a parts list of components that can be ordered from the laptop manufacturer. If you don't have this manual, your chances of successfully replacing an internal component are greatly reduced! Another helpful resource is searching the Internet for video tutorials for the teardown of the model you are using. If you don't have much experience disassembling a laptop, it isn't wise to attempt to do so without the service manual.
- Consider the warranty that might still apply to the laptop. Remember that opening the case of a laptop under warranty most likely will void the warranty.
- Make certain that any component you have purchased to replace an internal component will work in the model of laptop you are servicing.
- Take your time. Patience is needed to keep from scratching or marring plastic screw covers, hinges, and the case.
- As you work, don't force anything. If you do, you're likely to break it.

- Always wear an ESD strap or use other protection against ESD.
- When removing cables, know that some ribbon cable connectors are **ZIF connectors**, which stands for zero insertion force. To disconnect a cable from a ZIF connector, first lift up the connector's lever and then easily remove the cable, as shown in Figure 1-74. Figure 1-75 shows a laptop that uses three ZIF connectors to hold the three keyboard cables in place. For some ribbon cables, you simply pull the cable out of the connector. For these cables, it's best to use two tweezers, one on each side of the connector, to remove the cable.

Figure 1-74

To disconnect a ZIF connector, first lift up on the lever or locking bar to release the latch, and then remove the cable using the pull tab, which is blue on this laptop

Figure 1-75

Three ZIF connectors hold the three keyboard cables in place

Again, use a spudger, dental pick, or very small screwdriver to pry up a plastic cover hiding a screw.

- Some laptops use plastic screws that are intended to be used only once. The service manual will tell you to be careful not to overtighten these screws and to always use new screws when reassembling a laptop.
- Disassemble the laptop by removing each field replaceable unit (FRU) in the order given by the laptop's service manual.
- At some point in the disassembly process after all appropriate covers and screws have been removed, you must crack the case, which means you separate the top and bottom parts of the case. The parts might be tightly sealed together. To separate them, use a plastic or metal spudger to slide along the seal and pry open the case, as shown earlier in Figure 1-67.

When reassembling a laptop, consider these general tips:

- Reassemble the laptop in the reverse order you disassembled it. Follow each step carefully.

- Be sure to tighten, but not overtighten, all screws. Loose screws or metal fragments in a laptop can be dangerous; they might cause a short as they shift about inside the laptop.
- Before you install the battery or AC adapter, verify that there are no loose parts inside the laptop. Pick it up and gently shake it. If you hear anything loose, open the case, find the loose component, screw, spring, or metal flake, and fix the problem.

Exploring Laptop Internal Components

Core 1 Objective

- 1.1

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

Here is a list of important components you are likely to be instructed to remove when disassembling a laptop and the typical order you remove them. However, know that the components and the order of disassembly vary from one laptop to another:

- 1. **Remove or disable the battery pack.** To start the disassembly, disconnect all peripherals, remove discs from the optical drive, and shut down the system. Then, disconnect the AC adapter and remove the battery. Removing the battery (see Figure 1-76) assures you that no power is getting to the system, which keeps the laptop and you safe as you work. Some laptops and netbooks have built-in batteries. For these devices, follow the manufacturer instructions to disable the battery (often called Ship Mode), which prevents it from providing power to any component.

Figure 1-76

Remove the battery pack before opening a laptop case

- 2. **Remove the hard drive.** For some laptops, the hard drive is accessed by removing the hard drive compartment cover from the bottom of the laptop. For example, Figure 1-77 shows the hard drive is secured in its bay with screws. When you remove the screws and disconnect the ribbon cable, you can lift the drive from its bay. For other hard drives, you unplug the drive from its drive socket rather than disconnecting a ribbon cable from the drive.

Figure 1-77

Remove all screws that secure the hard drive in its bay

- 3. **Remove memory.** Laptops use smaller memory modules than the DIMMs used in desktop computers. Figure 1-78 shows a DIMM and a **SO-DIMM (small outline DIMM)** for size comparison. For one laptop, you first remove the memory/Mini PCI Express Card compartment cover to access the memory modules. Release two latches on both edges of the socket at the same time to remove the memory modules, as shown in Figure 1-79.

Figure 1-78

A DIMM used in desktops compared with a SO-DIMM used in laptops

Figure 1-79

Release the latches on both edges of the socket to remove the memory modules

- 4.

  Remove the wireless card. For the laptop in Figure 1-79, the Mini PCI Express wireless card is installed in the same compartment as the memory modules. Disconnect the two wires leading to the wireless antennas, which are located in the laptop lid. Next, remove the screw securing the wireless card, then pull the card directly away from the socket, as shown in Figure 1-80.

Figure 1-80

Pull the wireless card directly away from the socket to prevent damage to the card and socket

5. **Remove the optical drive.** The optical drive is secured by a single screw on the bottom of the laptop. After you remove the single screw holding the drive in place, slide the drive out of the case. See Figure 1-81.

Figure 1-81

Slide the optical drive out of the case after removing the screw securing the optical drive to the laptop

- 6.

  Crack the case. After removing compartment covers and the components accessible inside these compartments (for example, memory, optical drive, and hard drive), you are ready to remove any other screws as directed in the service manual, and then you can crack

the case. Use a spudger to slide along the seal between the case top and bottom, and pry open the plastic casing on the side, as shown in Figure 1-82.

Figure 1-82

Using a spudger helps prevent harming the casing when prying it open

- 7. **Remove the keyboard bezel.** The keyboard bezel is the keyboard casing surrounding the keyboard of a laptop. For some laptops, such as the one shown in Figure 1-83, the keyboard bezel is the top of the case. For other laptops, you remove the case top and then remove the keyboard. Once you remove screws and disconnect the cables from the motherboard, the keyboard bezel should easily lift away from the laptop, as shown in Figure 1-83. You might need a spudger to help.

Figure 1-83

Disconnect both the touch pad board cable and the keyboard cable to remove the keyboard

Other hardware components you are likely to find in a laptop case include the system board, CPU, heat sink, fan, and the LCD panel and components in the laptop lid.

Exploring Inside an All-in-One Computer

Core 1 Objective

- 1.1

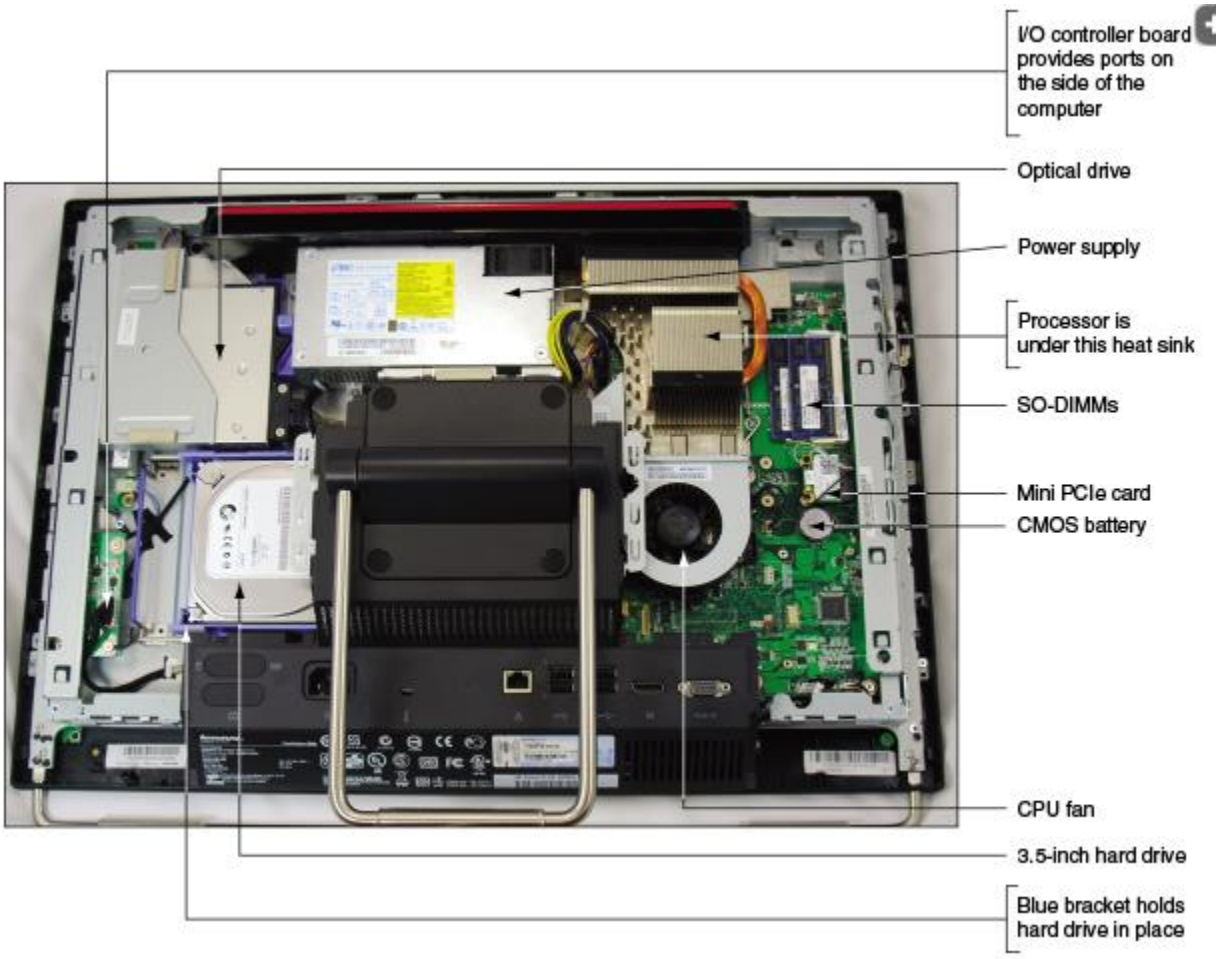
Given a scenario, install and configure laptop hardware and components.

An all-in-one computer uses a mix of components sized for a desktop computer and a laptop. Let's get the general idea of what's inside the case of an all-in-one by looking inside the Lenovo ThinkCentre all-in-one, which was shown earlier in Figure 1-56. Figure 1-84 shows the computer with the case cover removed. Notice that, in the figure, the hard drive is a 3.5-inch drive

appropriate for a desktop system, and the memory modules are SO-DIMMs appropriate for a laptop. So goes the hybrid nature of an all-in-one. The fan and heat sink look more like that of a laptop computer, but the processor socket on the motherboard is a desktop processor socket, another hybrid design.

Figure 1-84

Components inside an all-in-one computer



Several components are easy to exchange in this all-in-one without further disassembly. For example, the Mini PCIe card for wireless connectivity is easy to get to, as are the SO-DIMMs you can partially see on the right side of Figure 1-85.

Figure 1-85

A CMOS battery and Mini PCIe wireless card

To work inside an all-in-one, you'll need the service manual to know how to open the case and replace internal components. Replacements for some components, such as the motherboard and power supply, must be purchased from the all-in-one manufacturer because they are likely to be proprietary,

as with many laptop components. For specific directions about replacing parts in an all-in-one, see the service manual.

Now that you are familiar with some major components of a laptop, let's learn some special considerations when maintaining laptops.

Maintaining Laptops

Core 1 Objectives

- 1.1

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

- 1.3

Given a scenario, set up and configure accessories and ports of mobile devices.

Laptops and mobile devices tend not to last as long as desktop computers because they are portable and therefore subject to more wear and tear. A device's user manual gives specific instructions on how to care for the device. Those instructions follow these general guidelines:

- LCD panels on devices are fragile and can be damaged fairly easily. Take precautions against damaging a laptop or other device's LCD panel. Don't touch it with sharp objects like ballpoint pens.
- Don't pick up or hold a laptop by the lid. Pick it up and hold it by the bottom. Keep the lid closed when the laptop is not in use.
- Only use battery packs and AC adapters recommended by the laptop manufacturer. Keep the battery pack away from moisture or heat, and don't attempt to take the pack apart. When it no longer works, dispose of it correctly. For laptops, you might consider buying an extra battery pack to use when the first one discharges. You can also buy battery chargers so that you can charge one while the other is in use.
- Don't tightly pack a laptop or tablet in a suitcase because the LCD panel might get damaged. Use a good-quality carrying case, and make a habit of always transporting the laptop in the carrying case. Don't place heavy objects on top of the laptop case.
- Don't move the laptop while the hard drive is being accessed (when the drive indicator light is on). Wait until the light goes off.
- Don't put the laptop close to an appliance such as a TV, large audio speakers, or refrigerator that generates a strong magnetic field, and don't place your cell phone on a laptop while the phone is in use.
- Always use passwords to protect access to your laptop so you are better protected when connected to a public network or if the device is stolen or used by an unauthorized person.
- Keep your laptop or device at room temperature. For example, never leave it in a car overnight during cold weather, and don't leave it in a

car during the day in hot weather. Don't expose your laptop or device to direct sunlight for an extended time.

- Don't leave the laptop or device in a dusty or smoke-filled area. Don't use it in a wet area such as near a swimming pool or in the bathtub. Don't use it at the beach where sand can get in it.
- Don't power it up and down unnecessarily.
- Protect the laptop from overheating by not running it when it's still inside the carrying case, not resting it on a pillow, and not partially covering it with a blanket or anything else that would prevent proper air circulation around it.
- If a laptop has just been brought indoors from the cold, don't turn it on until it reaches room temperature. In some cases, condensation can cause problems. Some manufacturers recommend that when you receive a new laptop shipped to you during the winter, you should leave it in its shipping carton for several hours before you open the carton to prevent subjecting the laptop to a temperature shock.
- Protect a laptop against static electricity. If you have just come in from the cold on a low-humidity day when there is the possibility that you are carrying static electricity, don't touch the laptop until you have grounded yourself.
- Before placing a laptop in a carrying case for travel, remove any CDs, DVDs, or USB flash drives, and put them in protective covers. Verify that the system is powered down and not in sleep mode, which will drain the battery.
- If a laptop gets wet, you can partially disassemble it to allow internal components to dry. Give the laptop several days to dry before attempting to turn it on. Don't use heat to speed up the drying time.
- Keep current backups of important data on a laptop or device in case it fails or is stolen.

A well-used laptop, especially one that is used in dusty or dirty areas, needs cleaning occasionally. Here are some cleaning tips:

1. Clean the LCD panel with a soft, dry cloth. If the panel is very dirty, you can use monitor wipes or lightly dampened cloths to clean it. Some manufacturers recommend using a mixture of isopropyl alcohol and water to clean an LCD panel. Be sure the LCD panel is dry before you close the lid.
2. Use a can of compressed air meant for use on computer equipment to blow dust and small particles out of the keyboard, trackball, and touch pad. Turn the laptop at an angle and direct the air into the sides of the keyboard. Then use a soft, damp cloth to clean the key caps and touch pad.
3. Use compressed air to blow out all air vents on the laptop to make sure they are clean and unobstructed.

4. If a laptop is overheating, the CPU fan might be clogged with dust. The overheating problem might be solved by disassembling the laptop and blowing out the fan with compressed air.
5. If keys are sticking, remove the keyboard so you can better spray under the keys with compressed air. If you can remove the key cap, remove it and clean the key contact area with contact cleaner. One example of a contact cleaner you can use for this purpose is Stabilant 22 (stabilant.com). Reinstall the keyboard and test it. If the key still sticks, replace the keyboard.
6. Remove the battery and clean the battery connections with a contact cleaner.

Exam Tip

The A+ Core 1 exam expects you to know how to solve the problem of sticking keys on a laptop, given a scenario.

Module Review

1-3a Module Summary

Exploring a Desktop Computer

- When hardware support technicians disassemble or reassemble a computer, they need to stay organized, keep careful notes, and follow all the safety procedures to protect the computer equipment and themselves.
- Before opening a computer case, shut down the system, unplug it, disconnect all cables, and press the power button to drain residual power.
- Common tools for a computer hardware technician include an ESD strap, screwdrivers, tweezers, flashlight, compressed air, and cleaning solutions and pads.
- Special tools a hardware technician might need include a POST diagnostic card, power supply tester, multimeter, and loopback plugs.
- A computer's video ports might include the VGA, DVI, DisplayPort, and HDMI ports. Other ports include RJ-45, audio, SPDIF, USB, eSATA, PS/2, serial, and RJ-11 ports. A Thunderbolt port can transmit video, data, and power.
- Internal computer components include the motherboard, processor, expansion cards, DIMM memory modules, hard drive, optical drive, and power supply.
- Cases, power supplies, and motherboards use ATX and microATX 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 microATX form factors include the older 20-pin P1, current 24-pin P1, 4-pin and 8-pin CPU auxiliary motherboard, 4-pin Molex, 15-pin SATA, and 6/8-pin PCIe connectors.
- An expansion card fits in a slot on the motherboard and is anchored to the case by a single screw or clip.
- Firmware consists of the older BIOS (basic input/output system) firmware and the newer UEFI (Unified Extensible Firmware Interface) firmware. This BIOS/UEFI firmware is responsible for managing essential devices (for example, keyboard, mouse, hard drive, and monitor) before the OS is launched, starting the computer, and managing motherboard settings.
- Most hard drives and optical drives today use the serial ATA (SATA) standards for the drive to interface with the motherboard and power supply.

First Look at Laptop Components

- Laptop computers are designed for travel. They use the same technology as desktop computers, with modifications for space, portability, and power conservation. A laptop generally costs more than a desktop with comparable power and features.
- A laptop docking station or port replicator can make it easy to connect and disconnect peripheral devices.
- You can use the USB ports for expansion—for example, you can add a USB to RJ-45 dongle, a USB to Wi-Fi dongle, Bluetooth capability, or a USB optical drive.
- The laptop manufacturer documentation—including the service manual, diagnostic software, and recovery media—is useful when disassembling, troubleshooting, and repairing a laptop.
- Field replaceable units (FRUs) in a laptop can include the memory modules, hard drive, keyboard, Mini PCIe card, and wireless card.
- When an internal component needs replacing, consider the possibility of disabling the component and using an external peripheral device in its place. Don't jeopardize the warranty on a laptop by opening the case or using components not authorized by the manufacturer.
- Replacing the laptop might be more cost effective than performing labor-intensive repairs, such as replacing the system board.
- When disassembling a laptop, the manufacturer's service manual is essential.
- When upgrading components on a laptop, including memory, use components that are the same brand as the laptop, or use only components recommended by the laptop's manufacturer.
- Follow the directions in a service manual to disassemble a laptop. Keep small screws organized as you disassemble a laptop because they come in a variety of sizes and lengths. Some manufacturers use

plastic screws and recommend you use new screws rather than reuse the old ones.
- Special concerns when supporting a laptop also apply to supporting a netbook or all-in-one computer.
- When replacing an FRU, you might need to remove internal laptop components such as the keyboard, hard drive, memory, wireless card, and battery pack.
- An all-in-one computer uses a combination of components designed for desktop computers and laptops.

Module Review

1-3c Thinking Critically

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

1. You purchase a new desktop computer that does not have wireless capability, and then you decide that you want to use a wireless connection to the Internet. What are the two least expensive ways to upgrade your system to wireless? (Choose two.)

    1. Trade in the computer for another computer that has wireless installed.
    2. Purchase a second computer that has wireless capability.
    3. Purchase a wireless expansion card, and install it in your system.
    4. Purchase a USB wireless adapter, and connect it to the computer by way of a USB port.

2. What type of computer is likely to use SO-DIMMs, have an internal power supply, and use a desktop processor socket?

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

    1. You suspect the network port on a computer is not functioning.
    2. The system fails at the beginning of the boot, and nothing appears on the screen.
    3. A hard drive is not working, and you suspect the Molex power connector from the power supply might be the source of the problem.

4. You disassemble and reassemble a desktop computer. When you first turn it on, you see no lights and hear no sounds. Nothing appears on the monitor screen. What is the most likely cause of the problem? Explain your answer.

    1. A memory module is not seated properly in a memory slot.
    2. You forgot to plug in the monitor's external power cord.
    3. A wire in the case is obstructing a fan.
    4. Power cords to the motherboard are not connected.

5. You are looking to buy a laptop on a budget that requires you to service and repair the laptop yourself, and you want to save money by not purchasing an extended service

agreement beyond the first year. To limit your search, what should you consider when choosing manufacturers? Which manufacturers would you choose and why?

6. A four-year-old laptop will not boot and presents error messages on-screen. You have verified with the laptop technical support that these error messages indicate the wireless card has failed and needs replacing. What is the first step you should take to prepare for the repair?

    1. Ask yourself if replacing the wireless card will cost more than purchasing a new laptop.
    2. Find a replacement wireless card.
    3. Find the service manual to show you how to replace the wireless card.
    4. Ask if the laptop is still under warranty.

7. Why are laptops usually more expensive than desktop computers with comparable power and features?

8. When a laptop internal device fails, what three options can you use to deal with the problem?

9. A friend was just promoted to a new job that requires part-time travel, and they have been promised a new laptop after their first month with the company. They need an easy way to disconnect and reconnect all their peripheral devices to their new laptop. Devices include two external monitors (one HDMI, one DVI), a USB wireless mouse, USB wireless keyboard, Ethernet network, USB printer, headphones, and microphone. The budget is $100. What kind of device would best suit your friend's needs? Why? Research online to find a recommendation for a device that will work best. What is your recommendation and why?

10. Your laptop LCD panel is blank when you boot up. You can hear the laptop turn on, and the keyboard backlight is on. You have checked the brightness using the function keys, and that is not the problem. What is an easy next step to determine if the LCD panel has failed? Describe how that next step can also allow you to continue to use your laptop if the LCD panel has failed, but the replacement components won't arrive for a week.

11. A foreign exchange student brought a desktop computer from home (Europe) to the United States. The student brought a power adapter so that the power cord would plug into the power outlet and tried turning on their computer, but it wouldn't power on. What is likely the problem? What warning should you give when the student returns home at the end of the year?

12. You're building a new desktop computer from parts you picked out and purchased. You invested a good deal of money in this computer and want to be sure to protect your investment while you assemble it. What precautions should you take to protect your computer from damage and electrostatic discharge?

13. Your friend asks for your help because their laptop's Wi-Fi connection keeps dropping. What are some options you could offer your friend to fix the problem?

14. Your boss asks you to upgrade a desktop computer to add an extra DVI port for a second monitor. How would you recommend completing this request?

15. After troubleshooting a problem, you decide that the wireless card has failed in a laptop. What do you do first before you disassemble the laptop?