Portable Computing

"The great thing about a computer notebook is that no matter how much you stuff into it, it doesn't get bigger or heavier."

—Bill Gates, *Business @ The Speed of Thought*

In this chapter, you will learn how to

- **Describe the many types of portable computing devices available**
- **Explain ways to expand portable computers**
- **Manage and maintain portable computers**
- **Upgrade and repair portable computers**
- **Troubleshoot portable computers**

There are times when the walls close in, when you need a change of scenery to get that elusive spark that inspires greatness…or sometimes you just need to get away from your coworkers for a few hours because they're driving you nuts! For many occupations, that's difficult to do. You need access to your documents and spreadsheets; you can't function without e-mail or the Internet. In short, you need a computer to get your job done.

Portable computing devices combine mobility with accessibility to bring you the best of both worlds; portables enable you to take some or even all of your computing capabilities with you when you go. Featuring all the bells and whistles of a desktop system, many portables offer a seamless transition from desk to café table.

This chapter looks at the classic portable computer, essentially a desktop PC transformed into a mobile format. Classic portables run Windows, Mac OS X, or some flavor of Linux.

Other portable devices, such as smartphones and tablets, run mobile operating systems designed to take advantage of small form factors and touch screens. In practice (and on the CompTIA A+ exams), such mobile devices differ a lot from classic portable computers. These devices get their own "Mobile Devices" chapter later in the book.

801/802

■ Portable Computing Devices

All portable devices share certain features. For output, they use LCD screens, although these vary from 20-inch behemoths to diminutive 10-inch displays. Portable computing devices employ sound of varying quality, from bland mono playback to fairly nice faux-surround reproductions. All of them run on DC electricity stored in batteries when not plugged into an AC outlet.

When asked about portable computing devices, most folks describe the traditional clamshell **notebook** computer, such as the one in Figure 26.1, with built-in LCD monitor, keyboard, and input device (a *touchpad*, in this case). The notebook is also called a portable or a **laptop**. All the terms are synonymous. A typical laptop computer functions as a fully standalone PC, potentially even replacing the desktop. The one in Figure 26.1, for example, has all of the features you expect the modern PC to have, such as a fast CPU, lots of RAM, a high-capacity hard drive, an optical drive, and an adequate sound system. Attach it to a network and you can browse the Internet and send e-mail.

• Figure 26.1   A notebook PC

Input Devices

Portable computers come with a variety of input devices. Most have a fully functional keyboard and a device to control the mouse pointer.

Keyboard Quirks

Laptop keyboards differ somewhat from those of desktop PCs, primarily because manufacturers have to cram all the keys onto a smaller form factor. They use the QWERTY format, but manufacturers make choices with key size and placement of the non-alphabet characters. Almost every portable keyboard uses a **Function (FN) key** to enable some keys to perform a third duty. Figure 26.2 compares a standard desktop keyboard with a large portable keyboard. You'll note that the latter has no separate number pad on the right. To use the number pad, you press the FN key (lower left in this case) to transform the (7, 8, 9), (U, I, O), (J, K, L), and (M) keys into the (7, 8, 9), (4, 5, 6), (1, 2, 3), and (0) keys.

The FN key also enables you to toggle other features specific to a portable, such as network connectivity and external displays. We'll examine these options in the next section of the chapter.

• Figure 26.2　Keyboard comparison

Pointing Devices

Portables need a way to control your mouse pointer, but their smaller size requires manufacturers to come up with clever solutions. First, portables today have USB ports and can use every type of pointing device you'd see on a desktop. Second, early portables used *trackballs*, often plugged in like a mouse and clipped to the side of the case. Other models with trackballs placed them in front of the keyboard at the edge of the case nearest the user, or behind the keyboard at the edge nearest the screen.

The next wave to hit the laptop market was IBM's **TrackPoint** device, a joystick the size of a pencil eraser, situated in the center of the keyboard (see Figure 26.3). With the TrackPoint, you can move the pointer around without taking your fingers away from the "home" typing position. You use a forefinger to push the joystick around, and then click or right-click, using two buttons below the spacebar. This type of pointing device has since been licensed for use by other manufacturers, and it continues to appear on laptops today.

• Figure 26.3　IBM TrackPoint

By far the most common laptop pointing device found today is the **touchpad** (see Figure 26.4)—a flat, touch-sensitive pad just in front of the keyboard. To operate a touchpad, you simply glide your finger across its surface to move the pointer, and tap the surface once or twice to single- or double-click. You can also click by using buttons just below the pad. Most people get the hang of this technique after just a few minutes of practice. The main advantage of the touchpad over previous laptop pointing devices is that it uses no moving parts—a fact that can really extend the life of a hard-working laptop.

Some manufacturers today include a **multitouch** touchpad that enables you to perform actions with multiple fingers, such as scrolling up and down or swiping to another screen or desktop.

• Figure 26.4 Touchpad on a laptop

Display Types

Laptops come in a variety of sizes and at varying costs. One major contributor to the overall cost of a laptop is the size of the LCD screen. Most laptops offer a range between 10.1-inch to 17.3-inch screens (measured diagonally), while a few offer just over 20-inch screens.

Many manufacturers are phasing out the standard 4:3 aspect ratio screen in favor of the widescreen format. **Aspect ratio** is the comparison of the screen width to the screen height, as you'll recall from Chapter 21. Depending on screen resolution, widescreens can have varying aspect ratios of 10:6, 16:9, 16:9.5, or 16:10.

Laptop LCD screens come in a variety of supported resolutions, described with acronyms such as XGA, WXGA, WSXGA, and more. The *W* in front of the letters indicates widescreen. Table 26.1 lists commonly supported laptop display resolutions.

Laptop LCDs are the same in almost every way as desktop LCDs with a TFT screen, an inverter (if using a CCFL backlight), and a backlight (CCFL or LED). You know all about these screens from Chapter 21. Expect questions about laptop displays, but know that they're pretty much the same as desktop displays. The only major difference is that they contain an antenna, but we'll discuss this later in the chapter.

The two most common resolutions are WXGA for the 14- to 15-inch models and HD 1080 for the 17.3-inch models.

Table 26.1	Common Screen Resolutions	
Acronym	**Name**	**Native Resolution**
XGA	eXtended Graphics Array	1024 × 768
HD 720	HD 720	1280 × 720
WXGA (16:10)	Wide eXtended Graphics Array	1280 × 800
WXGA (16:9)	Wide eXtended Graphics Array	1366 × 768
SXGA	Super eXtended Graphics Array	1280 × 1024
SXGA+	Super eXtended Graphics Array Plus	1400 × 1050
HD 900	HD 900	1600 × 900
WSXGA+	Widescreen SXGA Plus	1680 × 1050
UXGA	Ultra eXtended Graphics Array	1600 × 1200
HD 1080	HD 1080	1920 × 1080
WUXGA	Widescreen UXGA	1920 × 1200

Laptop screens typically come with one of two types of finish: **matte** or **high-gloss**. The matte finish was the industry standard for many years and offered a good trade-off between richness of colors and the reduction of glare. The better screens have a wide viewing angle and decent response time. The major drawback for matte-finished laptop screens is that they wash out a lot in bright light. Using such a laptop at an outdoor café, for example, is almost hopeless during daylight.

Manufacturers released high-gloss laptop screens in 2006, and they rapidly took over many store shelves. The high-gloss finish offers sharper contrast, richer colors, and wider viewing angles when compared to the matte screens. Each manufacturer has a different name for high-gloss coatings. Dell calls theirs TrueLife, Acer calls theirs CrystalBrite, and HP calls theirs BrightView. The drawback to the high-gloss screens is that, contrary to what the manufacturers' claim, they pick up lots of reflection from nearby objects, including the user! So although they're usable outside during the day, you'll need to contend with increased reflection as well.

With the advent of LED backlighting for LCD panels, many manufacturers have switched back to an anti-glare screen, though they're not quite the matte screens of old. When the LED brightness is up high, these are lovely screens. (See the "Troubleshooting Portable Computers" section later in this chapter for issues specific to LED-backlit portables.)

As with other LCD technologies that you'll recall from Chapter 21, most LCD/LED screens use twisted nematic (TN) technology. Some laptop screens use In-Plane Switching (IPS) panels for the greater viewing angle and better color quality. You'll find IPS panels on expensive, professional-grade desktop-replacement portables.

What you will *not* find on portable PCs are two other display technologies, plasma and organic light-emitting diode (OLED). Plasma displays demand a lot more electricity than LCDs demand and are completely inappropriate for portable PCs. OLED screens sip energy when compared to LCDs, but they're still so expensive that you'll only find them on a few smartphones today. Chapter 27 discusses OLED screen technology.

The CompTIA A+ 801 exam objectives refer to plasma and OLED displays for laptops, but these don't exist. You'll find OLED displays on a few smartphones, but not on portable PCs, at least not at the time of this writing.

Desktop Replacements

A *desktop replacement* features a massive screen, a full-size keyboard, an optical drive (or maybe two), and plenty of hard drive space (see the portable on the left in Figure 26.5). Considering that it weighs almost as much as a minitower PC (or at least it feels like it does when I'm lugging it through the airport!), such a portable can be considered a **desktop replacement** because it does everything most people want to do with a desktop PC and doesn't compromise on performance just to make the laptop a few pounds lighter or the battery last an extra hour. Think power first, portability second.

The current sweet spot for desktop replacements is a 17.3-inch monitor with 16+ GB of DDR3 and either dual 1- to 2-TB HDDs or a single 512-GB to 1-TB SSD. Dedicated graphics are a must. Desktop replacements run the latest Intel high-end mobile processors and, of course, run Windows 7 64-bit edition. Such perfection in computing in a sub-8-pound format doesn't come cheap, so the question that immediately arises is, why buy a desktop replacement?

• **Figure 26.5** Desktop replacement (left) next to a standard portable computer (right)

Desktop replacements appeal to a diverse group of users. Most obviously, dedicated road warriors need to do everything on the plane, on the train, and in the hotel room. Second, having a computer that can work well on the road and in the office is convenient. Finally, some folks just prefer the compactness of a laptop. You can, after all, put it out of sight when you're finished with it and not have to dedicate space to an equally powerful desktop computer.

Netbooks

Netbooks offer a robust computing platform with low cost and long battery life. These machines usually have displays in the 10-inch range, small hard drives, and CPUs geared more for minimal power usage than raw speed.

A prime example of the netbook is the ASUS Eee PC, shown in Figure 26.6 sitting on a full-sized laptop. This netbook has a 9-inch screen, a 1.6-GHz Intel Atom CPU, and a small solid-state drive, and runs a customized Linux distribution. One distinguishing feature of these netbooks is the use of Intel's Atom processor. The Atom CPU is very useful for keeping power usage down but has much less computing power than its more power-hungry siblings. Therefore, most netbooks run either Windows 7 Starter edition or some form of Linux that is better suited for their limited resources.

• **Figure 26.6** ASUS Eee PC sitting on a normal laptop

Ultrabooks

Thin, light, and powerful, **Ultrabooks** are as much about power and portability as they are about looks. Ultrabooks are for people who can't give up the power of high-end computers but can afford to pay more for a smaller package. Intel set up the Ultrabook specifications in 2011, defining the form factor to use power-sipping Intel processors with integrated graphics. These Ultrabooks have maximum dimensions (18 to 23 mm thick, depending on the size of the screen) and a minimum battery life (5 hours). Several manufacturers are stepping into the Ultrabook market, mostly copying the thin-slice aesthetic of the MacBook Air. You won't find optical drives on these, and most use solid-state drives for storage. Some people find this limiting; those *in the know* (read: young people) won't care, as long as they can edit their HD movies while drinking at a coffee shop and looking good (see Figure 26.7).

Tablet PCs

Microsoft started the **Tablet PC** initiative way back in 2001, defining the devices as fully featured portables running a tablet-aware version of Windows and using a stylus to interact directly with the screen. Many Tablet PCs have come to market since then, fulfilling the needs of specific professions, notably medicine.

Instead of (or in addition to) a keyboard and mouse, Tablet PCs provide a screen that doubles as an input device. With a special pen, called a **stylus**, you can actually write on the screen (see Figure 26.8). Just make sure you don't grab your fancy Cross ballpoint pen accidentally and start writing on

Tablet PC is a Microsoft term and is *not* the equivalent of a tablet such as the Apple iPad or Samsung Galaxy Tab. The latter devices derive from the mobile phone market, as mentioned at the beginning of this chapter, so they're *not* PCs, but rather a unique class of mobile devices. According to Microsoft, a Tablet PC runs Windows. Chapter 27 covers mobile devices in detail.

• Figure 26.7   Ultrabook (photo courtesy of Intel Free Press)

the screen! Unlike some touch screens, most Tablet PC screens are not pressure sensitive—you have to use the stylus to write on the screen. Tablet PCs come in two main form factors: *convertibles*, which include a keyboard that you can fold out of the way, and *slates*, which do away with the keyboard entirely. The convertible Tablet PC in Figure 26.8, for example, looks and functions just like the typical clamshell laptop shown back in Figure 26.1. But here it's shown with the screen rotated 180 degrees and snapped flat so it functions as a slate. Pretty slick!

• **Figure 26.8**   A Tablet PC

Early Tablet PCs ran Windows XP Tablet edition. Windows Vista and Windows 7 support tablet features in all editions. You'll recall from Chapter 20 the dedicated Pen and Input Devices applet in Windows Vista. Windows Vista and 7 have a specific Tablet PC Settings applet (see Figure 26.9) that enables you to configure the tablet to recognize handwriting, place menus conveniently for right- or left-handed users, and more.

In applications that aren't "tablet-aware," the stylus acts just like a mouse, enabling you to select items, double-click, right-click, and so on. To input text with the stylus, you can either tap keys on a virtual keyboard (shown in Figure 26.10), write in the writing utility (shown in Figure 26.11), or use speech recognition software. With a little practice, most users find the computer's accuracy in recognizing their handwriting to be sufficient for most text input, although speedy touch-typists will probably still want to use a keyboard when typing longer documents.

Tablet PCs work well when you have limited space or have to walk around and use a laptop. Anyone who has ever tried to type with one hand while walking around the factory floor and holding the laptop with the other hand will immediately appreciate the beauty of a Tablet PC. In this scenario, Tablet PCs are most effective when combined with applications designed to be used with a stylus instead of a keyboard. An inventory control program, for example, might present drop-down lists and radio buttons to the user, making a stylus the perfect input tool. With the right custom application, Tablet PCs become indispensable tools.

Microsoft encourages software developers to take advantage of a feature they call *digital ink*, which allows applications to accept pen strokes as input without first converting the pen strokes into text or mouse-clicks. In Microsoft Journal, which comes with Tablet PCs, you can write on the screen just as though you were writing on
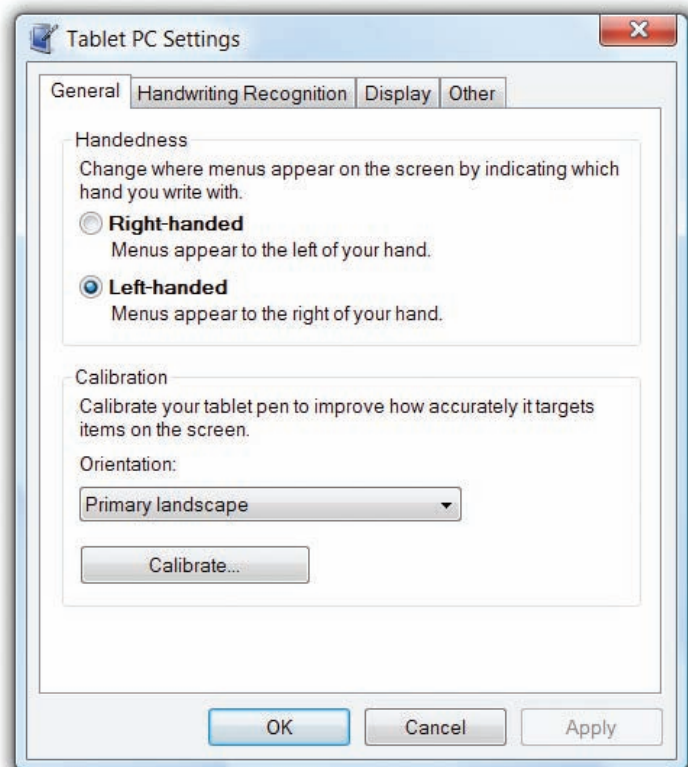

• **Figure 26.9**   Tablet PC Settings applet
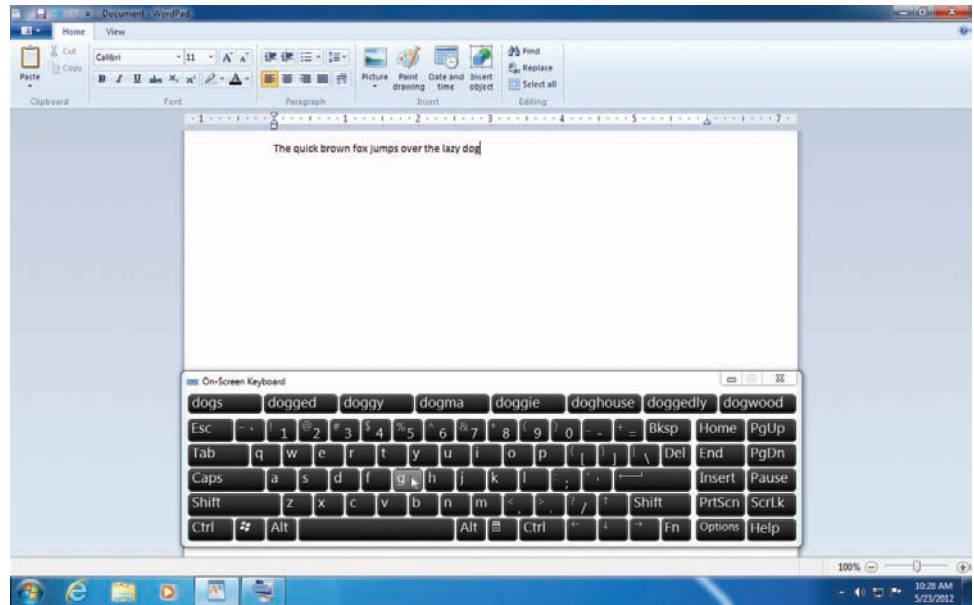
• **Figure 26.10**   The virtual keyboard

a paper legal pad (see Figure 26.12). Many other applications, including Microsoft Office, allow you to add ink annotations. Imagine sitting on an airplane reviewing a Microsoft Word document and simply scribbling your comments on the screen (see Figure 26.13). No more printing out hard copy and breaking out the red pen for me! Imagine running a PowerPoint presentation and being able to annotate your presentation as you go.

Many useful third-party applications are designed specifically to take advantage of the Tablet PC form factor. In fields such as law and medicine,
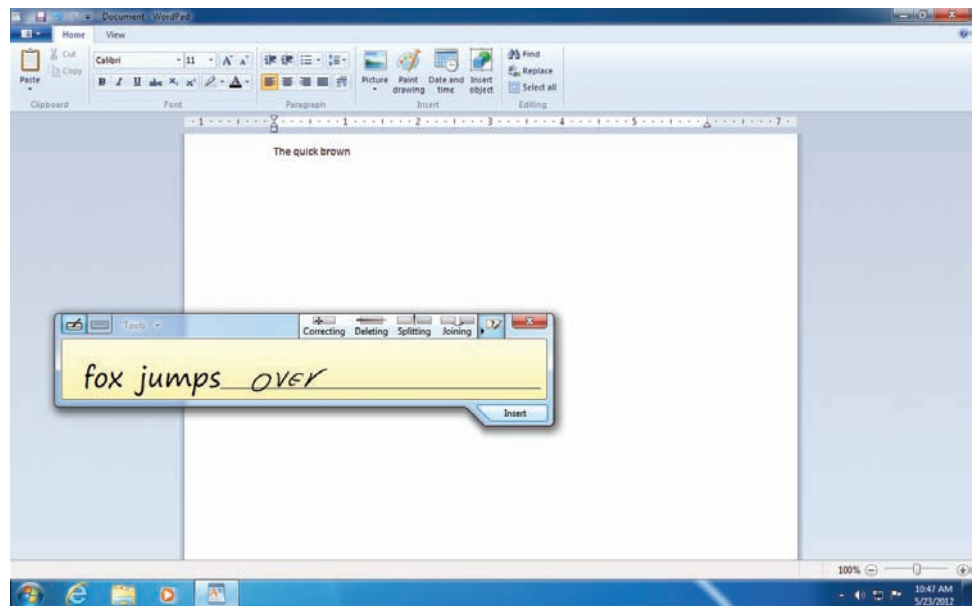
• **Figure 26.11**   The writing pad
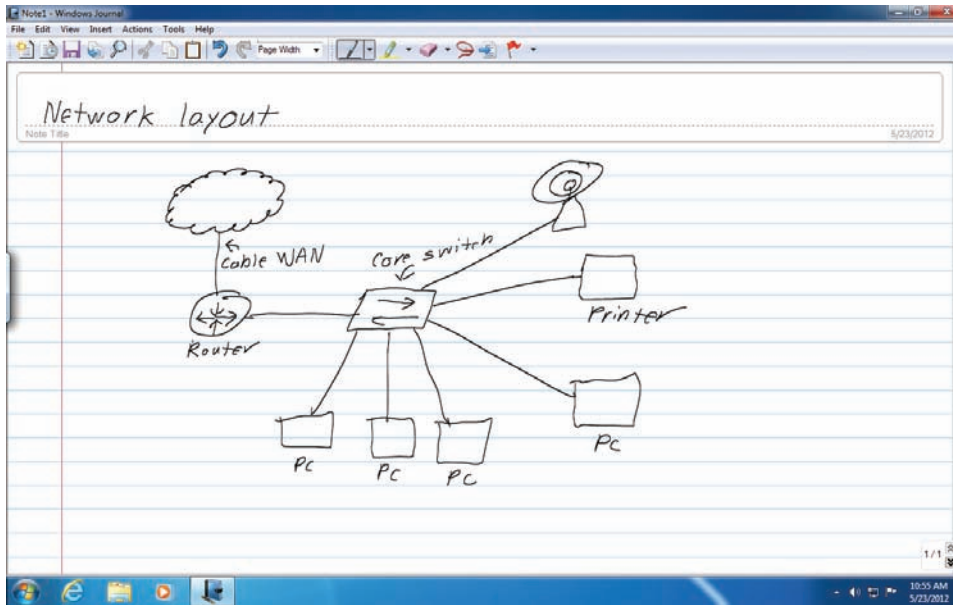
• **Figure 26.12** Microsoft Journal preserves pen strokes as digital ink.

where Tablet PCs have been especially popular, the choices are endless. One handy free utility that anyone who spends time in front of an audience (teachers, salespeople, cult leaders, and so on) will appreciate is InkyBoard (www.cfcassidy.com/Inkyboard). InkyBoard provides a virtual dry-erase board, eliminating the need to find a real board when holding meetings. Ever wished you could have a record of everything that was written on the chalkboard in a class (or business meeting)? If the professor had used Inky-Board, creating and distributing a copy would be a snap.
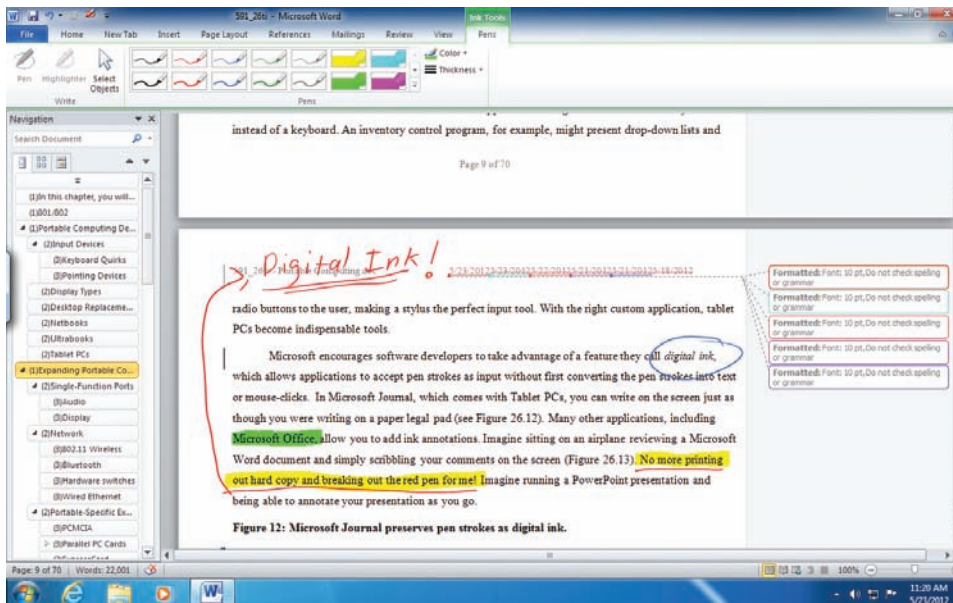
• **Figure 26.13** Microsoft Office supports digital ink.

■ Expanding Portable Computers

In the dark ages of mobile computing, you had to shell out top dollar for any device that would unplug, and what you purchased was what you got. Upgrade a laptop? Connect to external devices? You had few if any options, so you simply paid for a device that would be way behind the technology curve within a year and functionally obsolete within two.

Portable PCs today offer many ways to enhance their capabilities. Most feature external ports that enable you to add completely new functions to portables, such as attaching a scanner or mobile printer or both. You can take advantage of the latest wireless technology breakthrough simply by slipping a card into the appropriate slot on the laptop.

I'll first describe single-function ports, and then turn to networking options. Next, I'll cover card slots, and then finish with a discussion of general-purpose ports.

Single-Function Ports

All portable PCs come with one or more single-function ports. You'd have a hard time finding a portable computing device that doesn't have a speaker port, for example. Laptops invariably provide a video port such as a VGA or DVI connection for hooking up an external monitor.

Ports work the same way on portable PCs as they do on desktop models. You plug in a device to a particular port and, as long as Windows has the proper drivers, you will have a functioning device when you boot.
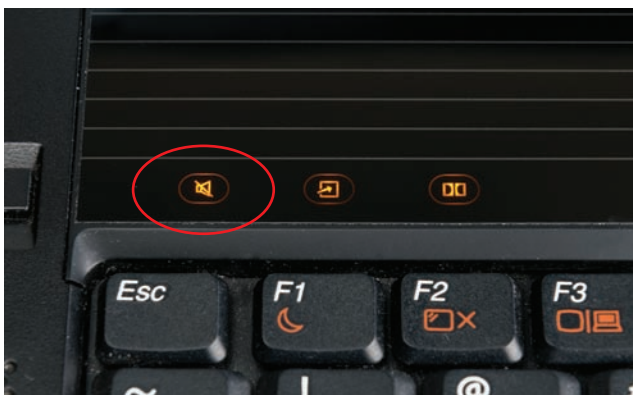

• Figure 26.14   Standard audio ports

Audio

Portable PCs have a standard 3.5-mm audio out port and some have a similarly sized microphone in port (see Figure 26.14). You can plug in regular PC speakers or even a nice surround sound set to enable the laptop to play music just as well as a desktop computer can.

You control the sound (both out and in) through either the appropriate Control Panel applet in Windows or through some kind of switches on the laptop. The portable in Figure 26.15, for example, enables you to mute the speakers by pressing a special mute spot above the keyboard. Other portables use a combination of the FN key and another key to toggle mute on and off. You can also find many variations on how to control the volume coming out of the machine. Few portable PCs have a manual volume dial these days, instead relying on key combinations or special keys for control.

• Figure 26.15   The mute spot on a laptop

Display

Most laptops support a second monitor via an analog VGA port or a digital port of some flavor, such as DVI, HDMI, Mini HDMI, Micro HDMI, or DisplayPort. With a second monitor attached, you can display Windows on only the laptop screen, on only the external monitor, or on both simultaneously. Not all portables can do all variations, but they're more common than not.

Most portables use the FN key plus another key on the keyboard to cycle through display options. Figure 26.16 shows a close-up of a typical keyboard with the Function key; note the other options you can access with the Function key, such as indicated on the F2 key. To engage the second monitor or to cycle through the modes, hold the Function key and press F2.

You can control how the external monitor displays through the Display applet in the Control Panel. Open Display and click on *Change display settings* (see Figure 26.17). Under the Screen Resolution panel, click the drop-down arrow next to Multiple displays (see Figure 26.18). You'll see several options. *Extend these displays* makes your desktop encompass both the laptop and the external monitor. *Duplicate these displays* places the

• **Figure 26.16** Laptop keyboard showing Function (FN) key that enables you to access additional key options, as on the F2 key

Although many laptops use the Function key method to cycle the monitor selections, that's not always the case. You might have to pop into the Display applet in the Control Panel to click a checkbox. Just be assured that if the laptop has a video output port, you can cycle through monitor choices!
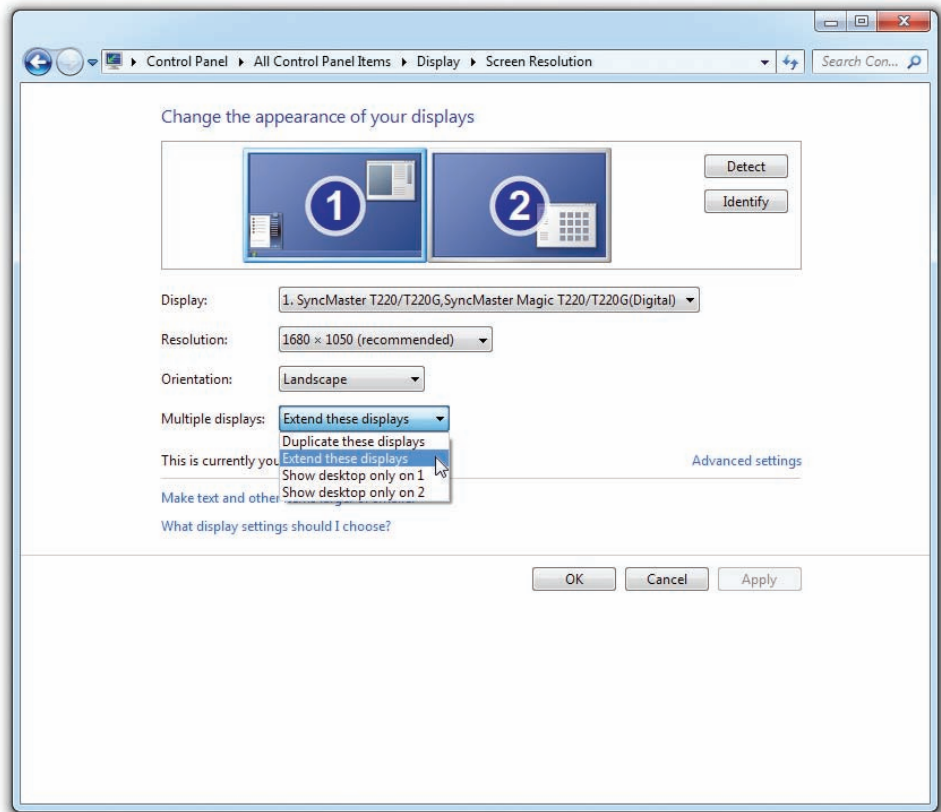
In Windows 7, the Windows key + P keyboard shortcut switches between multiple display modes.
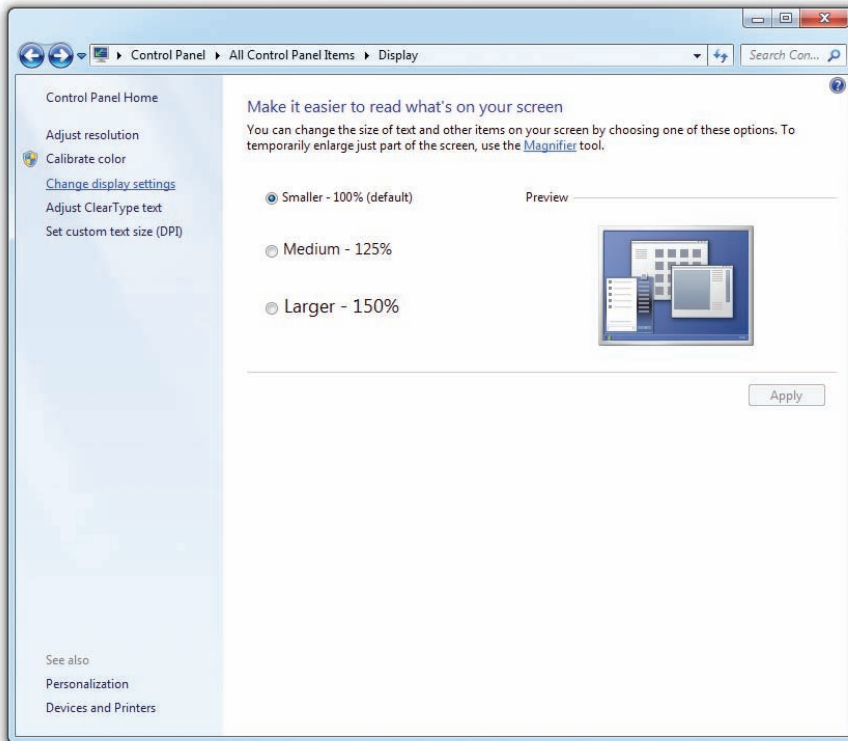
• **Figure 26.17** Display applet

The CompTIA A+ 802 exam objectives refer to multiple monitors as *dual displays*, though they can be in several modes.

same thing on both displays. You'd use that for a presentation, for example, rather than for a work space. (The other two options shown in Figure 26.18 temporarily blank one or the other display.)

Network

It's a rare item to find a portable computer without at least one network connection option. Today's laptops come with 802.11, Bluetooth, and wired Ethernet connections. Some still have modems for connecting to older-style telephone jacks. Generally they work exactly as you've seen in previous chapters, but you may stumble into a few issues that are unique to laptops.

802.11 Wireless

Most portables today have Wi-Fi built directly into the chipset for connecting the device to a wireless access point (WAP) and from there to a bigger network, such as the Internet. The 802.11b standard is common on older laptops; newer ones use 802.11g or 802.11n.

Bluetooth

While not nearly as common as 802.11, plenty of laptops use Bluetooth as well. Bluetooth is really handy on a laptop because it gives you the ability to add wireless mice, keyboards, and headsets.

Hardware Switches

Laptops that come with 802.11 or Bluetooth have some form of on/off switch to toggle the antenna off or on so that you may use the laptop in areas where emissions aren't allowed (like a commercial aircraft). The switch may be hard wired, like the one shown in Figure 26.19, or it may be a toggle of the FN key plus another key on the keyboard. Also, if you're not using Wi-Fi or Bluetooth, turn them off to save electricity and lengthen the portable's battery life.

Wired Ethernet

Most laptops have an RJ-45 wired Ethernet connection like the one shown in Figure 26.20. These work exactly like any other Ethernet jack—they have link lights and connect via UTP cable.

There are two issues with RJ-45s on laptops. First, they do not have an on/off switch like the 802.11 and Bluetooth connections. You can turn them off just like you would turn off the NIC on a desktop: disable the NIC in Device Manager or turn the NIC off in BIOS. The other issue is the relative weakness of the physical connection. If you ever plug a laptop into a wired network and Windows doesn't see a connection, check the RJ-45 port.

Portable-Specific Expansion Slots

The makers of portable computers have developed methods for you to add features to a portable via specialized connections known generically as *expansion slots*. Once a common feature on laptops, these specialized expansion slots are quickly fading away due to the dominance of USB. Yet you'll still find laptops with these slots (and they're covered on the CompTIA A+ exams), so let's take a look at expansion slots over the years.

PCMCIA

For many years, the *Personal Computer Memory Card International Association* (*PCMCIA*) established standards involving portable computers, especially when it came to expansion cards, which are generically called PC Cards. **PC Cards** are roughly credit card–sized devices that enhance and extend the functions of a portable PC. PC Cards are easy to use, inexpensive, and convenient. Figure 26.21 shows a typical PC Card.

Older portable PCs come with one or two PC Card slots, into which you insert a PC Card. Each card has at least one

• Figure 26.19   Wireless switch

• Figure 26.20   Ethernet port on laptop

• Figure 26.21   PC Card

• **Figure 26.22**   PC Card slots

function, but many have two, three, or more! You can buy a PC Card that offers connections for removable media, for example, such as combination SD and CF card readers. You can also find PC Cards that enable you to plug into multiple types of networks. All PC Cards are hot-swappable, meaning you can plug them in without powering down the PC.

The PCMCIA established two versions of PC Cards, one using a parallel bus and the other using a serial bus. Each version, in turn, offers two technology variations as well as several physical varieties. This might sound complicated at first, but here's the map to sort it all out.

Parallel PC Cards

Parallel PC Cards come in two flavors, **16-bit** and **CardBus**, and each flavor comes in three physical sizes, called Type I, Type II, and Type III. The 16-bit PC Cards, as the name suggests, are 16-bit, 5-V cards that can have up to two distinct functions or devices, such as a modem/network card combination. CardBus PC Cards are 32-bit, 3.3-V cards that can have up to eight (!) functions on a single card. Regular PC Cards fit into and work in CardBus slots, but the reverse is not true. CardBus totally dominates the current PC Card landscape, but you might still run into older 16-bit PC Cards.

Type I, II, and III cards differ only in the thickness of the card (Type I being the thinnest, and Type III the thickest). All PC Cards share the same 68-pin interface, so any PC Card will work in any slot that accepts that card type. Type II cards are by far the most common of PC Cards. Therefore, most older laptops have two Type II slots, one above the other, so the computer can accept two Type I or II cards or one Type III card (see Figure 26.22).

Although PCMCIA doesn't require that certain sizes perform certain functions, most PC Cards follow their recommendations. Table 26.2 lists the sizes and typical uses of each type of PC Card.

ExpressCard

Slots for **ExpressCard**, the high-performance serial version of the PC Card, have replaced PC Card slots on laptop PCs over the last decade. ExpressCard comes in two widths: 34 mm and 54 mm, called *ExpressCard/34* and *ExpressCard/54*. Figure 26.23 shows both ExpressCard varieties. Both cards are 75 mm long and 5 mm thick, which makes them shorter than all previous PC Cards and the same thickness as a Type II PC Card.

Table 26.2	PC Card Types and Their Typical Uses			
Type	**Length**	**Width**	**Thickness**	**Typical Use**
Type I	85.6 mm	54.0 mm	3.3 mm	Flash memory
Type II	85.6 mm	54.0 mm	5.0 mm	I/O (modem, NIC, and so on)
Type III	85.6 mm	54.0 mm	10.5 mm	Hard drives

ExpressCards connect to either the USB 2.0 bus or the PCI Express bus. These differ phenomenally in speed. The amazingly slow-in-comparison USB version has a maximum throughput of 480 Mbps. The PCIe version, in contrast, roars in at 2.5 Gbps in unidirectional communication.

Table 26.3 shows the throughput and variations for the parallel and serial PC Cards currently on the market.

PCMCIA announced ExpressCard 2.0 in 2009 with speeds up to 5 Gbps and support for SuperSpeed USB 3.0, and we expected to see devices roll out in 2010, but that's not what happened. PCMCIA has dissolved and shut its offices. The USB Implementer's Forum now manages all PC Card and ExpressCard standards, and there's not likely to be any further development.

Storage Card Slots

Many portable computers offer one or more flash-memory card slots to enable you to add storage to the portable. These slots also enable the fast transfer of data from the card to the portable, and vice versa. They come in the standard varieties that you already know from Chapter 13, such as SD, CompactFlash, and xD.

• **Figure 26.23**   34-mm and 54-mm ExpressCards

You can find ExpressCards that supposedly support USB 3.0. While technically these cards have USB 3.0 ports, they connect to the PCIe bus and therefore aren't capable of true USB 3.0 speeds of up to 5 Gbps.

General-Purpose Ports

Laptops rarely come with all of the hardware you want. Today's laptops usually include at least USB ports to give you the option to add more hardware. Some laptops still provide legacy general-purpose expansion ports (PS/2, RS-232 serial ports, and so on) for installing peripheral hardware, while other portables focus on more modern ports like eSATA and FireWire. If you're lucky, you will have a docking station or port replicator so you don't have to plug in all of your peripheral devices one at a time.

USB, FireWire, and eSATA

Universal serial bus (USB), FireWire (or more properly, IEEE 1394), and eSATA enable users to connect a device while the PC is running—you won't have to reboot the system to install a new peripheral. With USB, FireWire, and eSATA, just plug the device in and go! Because portable PCs don't have a desktop's multiple internal expansion capabilities, USB, FireWire, and

The small device resting in a stand in Figure 26.24 is called a *personal digital assistant* (*PDA*), a precursor to modern smartphones and tablets such as the Apple iPhone and iPad. You could view pictures, take notes, check a calendar, listen to music, and more on these devices. Expect PDA as an answer choice in exam questions, but most likely as one of the wrong answers. PDAs are rarely used today.

Table 26.3	PC Card Speeds
Standard	**Maximum Theoretical Throughput**
PC Card using 16-bit bus	160 Mbps
CardBus PC Card using PCI bus	1056 Mbps
ExpressCard using USB 2.0 bus	480 Mbps
ExpressCard using PCIe bus	2.5 Gbps

Cross Check

Modern General-Purpose Ports

You learned about eSATA in Chapter 11. You explored USB and FireWire back in Chapter 3 and in Chapter 20. What kind of connectors do eSATA, USB, and FireWire use? What are the cable length limitations? How many devices can each technology support?

eSATA are three of the more popular methods for attaching peripherals to laptops (see Figure 26.24).
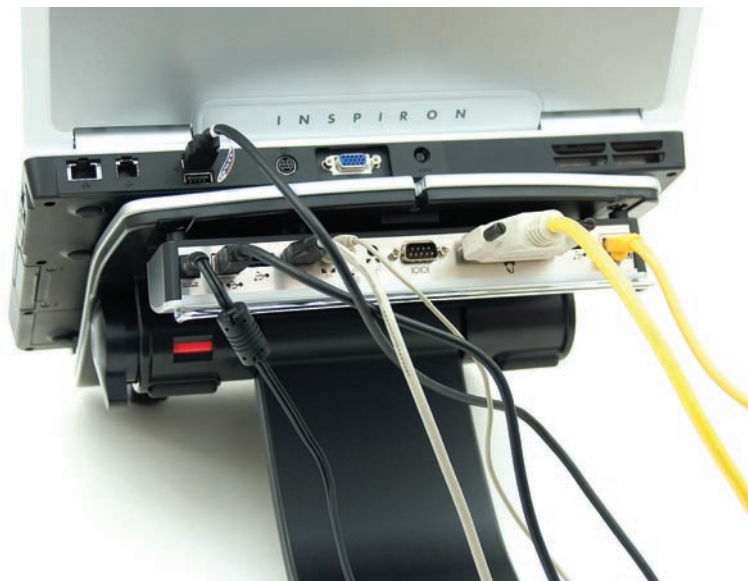
Port Replicators

A **port replicator** plugs into a single port on the portable computer—often a USB port but sometimes a proprietary port—and offers uncommon and common PC ports, such as serial, parallel, USB, network, and PS/2. By plugging the port replicator into your notebook computer, you can instantly connect the computer to nonportable components such as a printer, scanner, monitor, or a full-sized keyboard. Port replicators are typically used at home or in the office with the nonportable equipment already connected. Figure 26.25 shows a Dell Inspiron laptop connected to a port replicator.

The computer can access any devices attached to the port replicator; you don't need to connect each individual device to the PC. As a side bonus, port replicators enable you to attach legacy devices, such as parallel printers, to a new laptop

• Figure 26.24   Devices attached to USB on a portable PC

Although portable PCs most often connect to port replicators via USB ports, some manufacturers have proprietary connections for proprietary port replicators. As long as such a portable PC has a USB port, you can use either the proprietary hardware or the more flexible USB devices.

• Figure 26.25   Port replicator for a Dell portable computer

that only has modern multifunction ports such as USB and FireWire and not parallel or serial ports.

Docking Stations

Docking stations resemble port replicators in many ways, offering legacy and modern single- and multi-function ports (see Figure 26.26). The typical docking station uses a proprietary connection but has extra features built in, such as a DVD drive or PC Card slot for extra enhancements. You can find docking stations for many older small laptops. A docking station makes an excellent companion to such portables.

• Figure 26.26   Docking station

■ Managing and Maintaining Portable Computers

Most portable PCs come from the factory solidly built and configured. Manufacturers know that few techs outside their factories know enough to work on them, so they don't cut corners. From a tech's standpoint, your most common work on managing and maintaining portables involves taking care of the batteries and extending the battery life through proper power management, keeping the machine clean, and avoiding excessive heat.

Everything you normally do to maintain a PC applies to portable PCs. You need to keep current on Windows patches and service packs and use stable, recent drivers. Run Check Disk with some frequency, and definitely defragment the hard drive. Disk Cleanup is a must if the laptop runs Windows. That said, let's look at issues specifically involving portables.

Batteries

Manufacturers have used three types of batteries for portable PCs: **Nickel-Cadmium (Ni-Cd)**, **Nickel-Metal Hydride (Ni-MH)**, and **Lithium-Ion (Li-Ion)**. Today, only Li-Ion is used because that battery chemistry provides the highest energy density for the weight and has few problems with external factors. Let's look at each battery type briefly.

Nickel-Cadmium

Ni-Cds were the first batteries commonly used in mobile PCs, which means the technology was full of little problems. Probably most irritating was a little thing called *battery memory*, or the tendency of a Ni-Cd battery to lose a significant amount of its rechargeability if it was charged repeatedly without being totally discharged. A battery that originally kept a laptop running for two hours would eventually only keep that same laptop going for 30 minutes or less. Figure 26.27 shows a typical Ni-Cd battery.

• Figure 26.27   Ni-Cd battery

• **Figure 26.28**   Ni-MH battery

Nickel-Metal Hydride

Ni-MH batteries were the next generation of mobile PC batteries and are basically Ni-Cd batteries without most of the headaches. Ni-MH batteries are much less susceptible to memory problems, can tolerate overcharging better, can take more recharging, and can last longer between rechargings. Like Ni-Cds, Ni-MH batteries are susceptible to heat, but at least they are considered less toxic to the environment. Figure 26.28 shows a typical Ni-MH battery.

Lithium-Ion

The most common battery used today is Li-Ion. Li-Ion batteries are powerful, completely immune to memory problems, and last at least twice as long as comparable Ni-MH batteries on one charge. Sadly, they can't handle as many charges as Ni-MH types, but today's users are usually more than glad to give up total battery lifespan in return for longer periods between charges. Li-Ion batteries will explode if they are overcharged, so all Li-Ion batteries sold with PCs have built-in circuitry to prevent accidental overcharging. Lithium batteries can only be used on systems designed to use them. They can't be used as replacement batteries. Figure 26.29 shows a typical Li-Ion battery.

The Care and Feeding of Batteries

In general, keep in mind the following basics. First, always store batteries in a cool place. Although a freezer is in concept an excellent storage place, the moisture, metal racks, and food make it a bad idea. Second, keep the battery charged, at least to 70–80 percent. Third, never drain a battery all the way down unless required to do so as part of a *battery calibration* (where you, in essence, reset the battery according to steps provided by the manufacturer). Rechargeable batteries have only a limited number of charge-discharge cycles before overall battery performance is reduced. Fourth, *never* handle a battery that has ruptured or broken; battery chemicals are very dangerous. Finally, always recycle old batteries.

• **Figure 26.29**   Li-Ion battery

Power Management

Many different parts are included in the typical laptop, and each part uses power. The problem with early laptops was that every one of these parts used power continuously, whether or not the system needed that device at that time. For example, the hard drive continued to spin even when it was not being accessed, and the LCD panel continued to display even when the user walked away from the machine.

The optimal situation would be a system where the user could instruct the PC to shut down unused devices selectively, preferably by defining a maximum period of inactivity that, when reached, would trigger the PC to shut down the inactive device. Longer periods of inactivity would eventually enable the entire system to shut itself down, leaving critical information loaded in RAM, ready to restart if a wake-up event (such as moving the mouse or pressing a key) told the system to restart. The system would have to be sensitive to potential hazards, such as shutting down in the middle of writing to a drive, and so on. Also, this feature could not add significantly to the cost of the PC. Clearly, a machine that could perform these functions would need specialized hardware and a specialized BIOS and operating system to operate properly. This process of cooperation among the hardware, the BIOS, and the OS to reduce power use is known generically as *power management*.

System Management Mode

Intel began the process of power management with a series of new features built into the 386SX CPU. These new features enabled the CPU to slow down or stop its clock without erasing the register information, as well as enabling power saving in peripherals. These features were collectively called **System Management Mode (SMM)**. All modern CPUs have SMM. Although a power-saving CPU was okay, power management was relegated to special "sleep" or "doze" buttons that would stop the CPU and all of the peripherals on the laptop. To take real advantage of SMM, the system needed a specialized BIOS and OS to go with the SMM CPU. To this end, Intel put forward the **Advanced Power Management (APM)** specification in 1992 and the **Advanced Configuration and Power Interface (ACPI)** standard in 1996.

Requirements for APM/ACPI

To function fully, APM and ACPI require a number of items. First, they require an SMM-capable CPU. As virtually all CPUs are SMM-capable, this is easy. Second, they need an APM-compliant BIOS that enables the CPU to shut off the peripherals when desired. The third requirement is devices

Try This!

Recycling Old Portable PC Batteries

Got an old portable PC battery lying around? Well, you need to get rid of it, and there are some pretty nasty chemicals in that battery, so you can't just throw it in the trash. Sooner or later, you'll probably need to deal with such a battery, so Try This!

1. Do an online search to find the battery recycling center nearest to you.

2. Sometimes, you can take old laptop batteries to an auto parts store that disposes of old car batteries—I know it sounds odd, but it's true! See if you can find one in your area that will do this.

3. Many cities offer a hazardous materials disposal or recycling service. Check to see if and how your local government will help you dispose of your old batteries.

that will accept being shut off. These devices are usually called Energy Star devices, which signals their compliance with the EPA's Energy Star standard. To be an Energy Star device, a peripheral must be able to shut down without actually turning off and show that it uses much less power than the non–Energy Star equivalent. Last, the system's OS must know how to request that a particular device be shut down, and the CPU's clock must be slowed down or stopped.

ACPI goes beyond the APM standard by supplying support for hot-swappable devices—always a huge problem with APM. This feature aside, it is a challenge to tell the difference between an APM system and an ACPI system at first glance.

APM/ACPI Levels

APM defined four power-usage operating levels for a system. These levels are intentionally fuzzy to give manufacturers considerable leeway in their use; the only real difference among them is the amount of time each takes to return to normal usage. These levels are as follows:

- **Full On**   Everything in the system is running at full power. There is no power management.

- **APM Enabled**   CPU and RAM are running at full power. Power management is enabled. An unused device may or may not be shut down.

- **APM Standby**   CPU is stopped. RAM still stores all programs. All peripherals are shut down, although configuration options are still stored. (In other words, to get back to APM Enabled, you won't have to reinitialize the devices.)

- **APM Suspend**   Everything in the PC is shut down or at its lowest power-consumption setting. Many systems use a special type of Suspend called **hibernation**, where critical configuration information is written to the hard drive. Upon a wake-up event, the system is reinitialized, and the data is read from the drive to return the system to the APM Enabled mode. Clearly, the recovery time between Suspend and Enabled will be much longer than the time between Standby and Enabled.

ACPI, the successor to APM, handles all these levels plus a few more, such as "soft power on/off," that enables you to define the function of the power button. You should familiarize yourself with the following ACPI global (G) and sleeping (S) system power state specifications for both the CompTIA A+ exams and your own practical application:

- **G0 (S0)**   Working state
- **G1**   Sleeping state mode. Further subdivided into four *S* states:
  - **S1**   CPU stops processing. Power to CPU and memory (RAM) is maintained.
  - **S2**   CPU is powered down.
  - **S3**   Sleep or Standby mode. Power to RAM still on.
  - **S4**   Hibernation mode. Information in RAM is stored to nonvolatile memory or drive and powered off.

- **G2** (**S5**) Soft power off mode. Certain devices used to wake a system—such as keyboard, LAN, USB, and other devices—remain on, while most other components are powered to a mechanical off state (G3).

- **G3** Mechanical off mode. The system and all components, with the exception of the real-time clock (RTC), are completely powered down.

Configuration of APM/ACPI

You configure APM/ACPI via CMOS settings or through Windows. Windows settings override CMOS settings. Although the APM/ACPI standards permit a great deal of flexibility, which can create some confusion among different implementations, certain settings apply generally to CMOS configuration. First is the ability to initialize power management; this enables the system to enter the APM Enabled mode. Often CMOS then presents time frames for entering Standby and Suspend modes, as well as settings to determine which events take place in each of these modes.
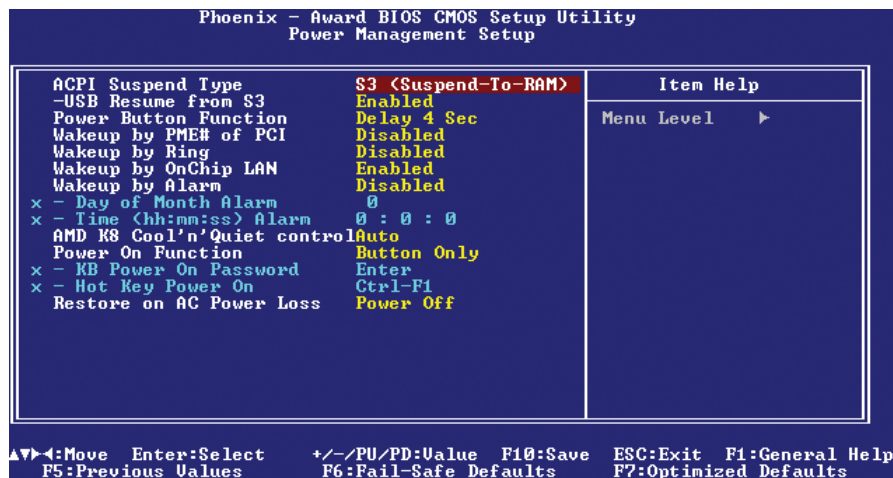
Many CMOS versions present settings to determine wake-up events, such as directing the system to monitor a modem or a NIC (see Figure 26.30). You'll see this feature as *Wake on LAN*, or something similar. A true ACPI-compliant CMOS provides an ACPI setup option. Figure 26.31 shows a typical modern BIOS that provides this setting.
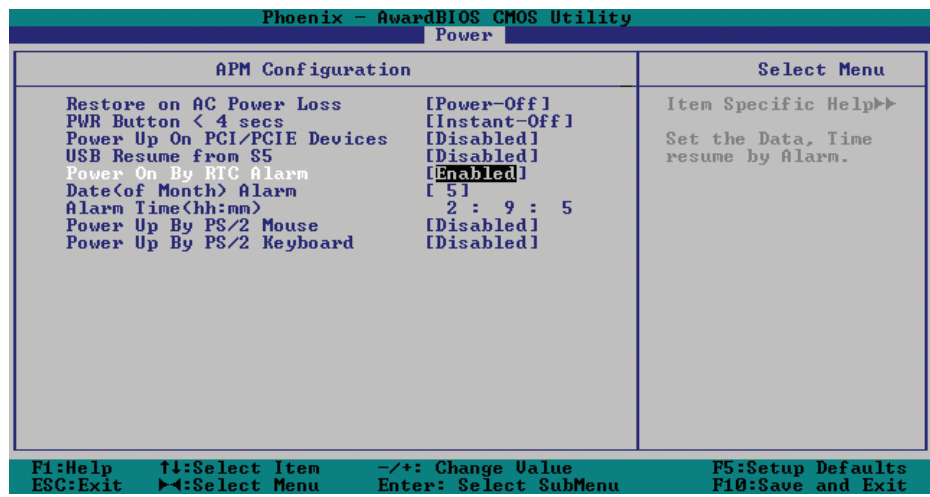

• **Figure 26.30**   Setting a wake-up event in CMOS

• **Figure 26.31**   CMOS with ACPI setup option

In Windows XP, you can also access your power options by right-clicking on the desktop, selecting Properties, and then clicking the Power button in the Monitor power section of the Screen Saver tab. In Windows Vista and 7, right-click the desktop, select Personalize, select Screen Saver, and then click on the *Change power settings* link.
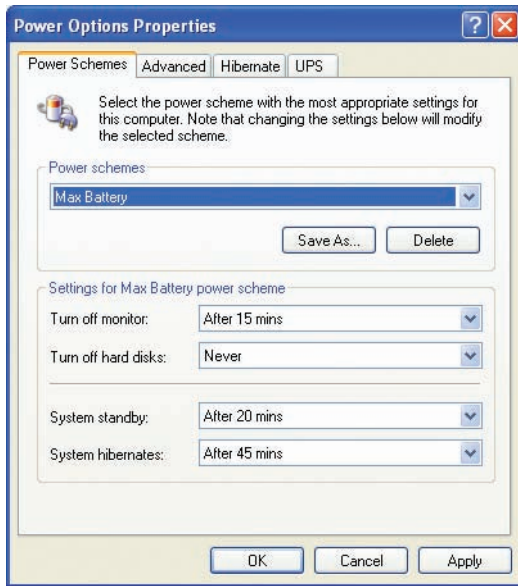
• Figure 26.32   The Windows XP Power Options applet's Power Schemes tab

APM/ACPI settings can be found in the Control Panel applet Power Options. In Windows XP, the Power Options applet has several built-in *power schemes* such as Home/Office and Max Battery that put the system into Standby or Suspend after a certain interval (see Figure 26.32). You can also require the system to go into Standby after a set period of time or to turn off the monitor or hard drive after a time, thus creating your own custom power scheme. This is technically called adjusting the **sleep timers**.

Windows Vista and Windows 7 offer **power plans** that enable better control over power use by customizing a balanced, power saver, or high performance power plan (see Figure 26.33). You can customize a power saver plan for your laptop, for example, and configure it to turn off the display at a certain time interval while on battery or plugged in and configure it to put the computer to sleep as desired (see Figure 26.34).

Another feature, Hibernate mode, takes everything in active memory and stores it on the hard drive just before the system powers down. When the PC comes out of hibernation, Windows reloads all the files and applications into RAM. Figure 26.35 shows the Power Options Properties applet in Windows XP.

Manual Control over Power Use

Most portable PCs give you several manual options for reducing battery use in certain circumstances. We've already discussed using the on/off switch or keyboard combination for disabling the Wi-Fi antenna, for example, and shutting off Bluetooth. Laptops with backlit keyboards
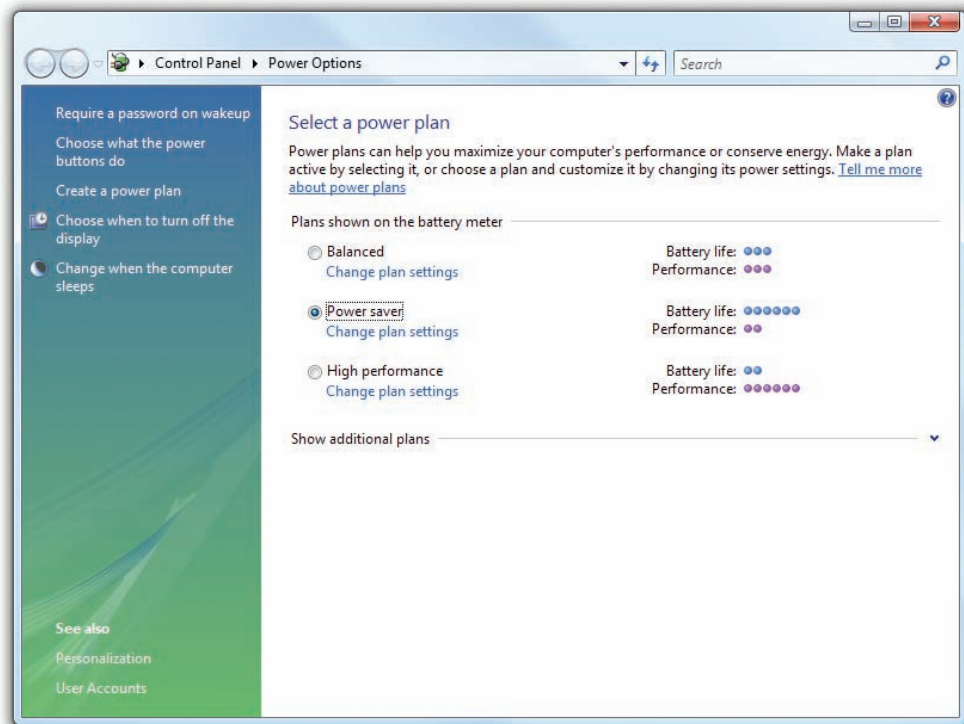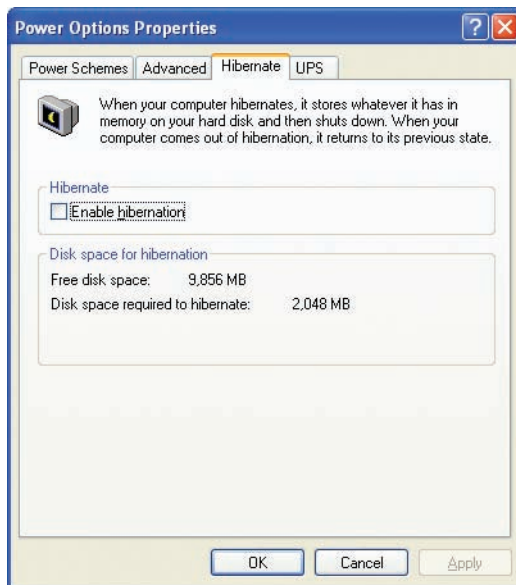

• Figure 26.33   Windows Vista Balanced, Power saver, and High performance power plan options

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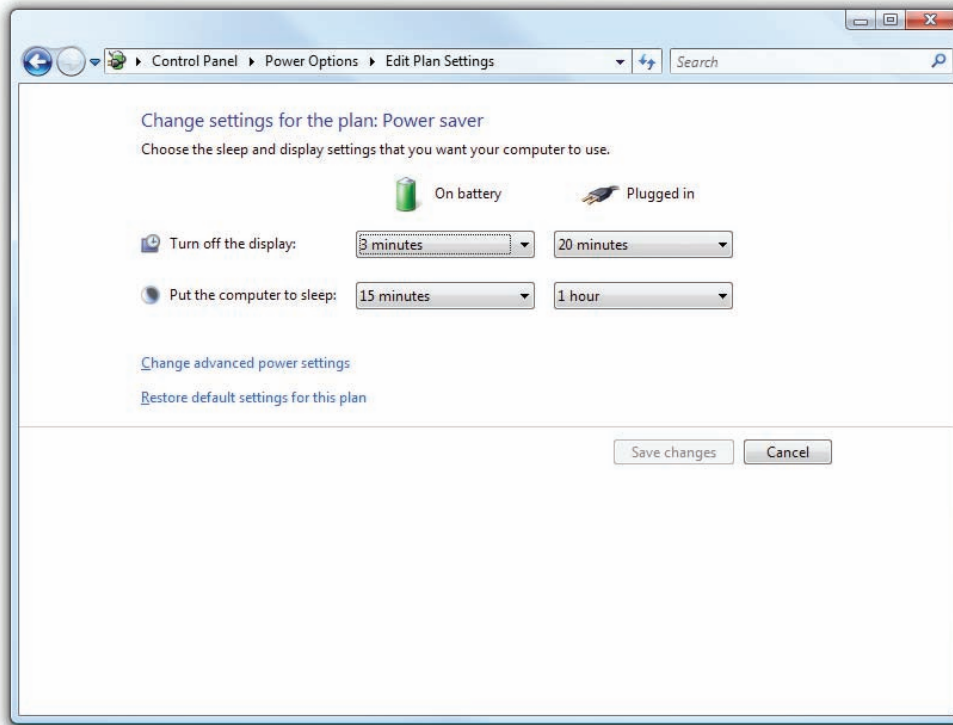
• **Figure 26.34**   Customizing a laptop power plan in Windows Vista

will have some way you can disable this feature when it's not needed, usually with a keyboard combination. You can also reduce the output of the LCD backlight using a combination of FN and another key to eke out a few more precious minutes of computing time before you have to shut down.

• **Figure 26.35**   Windows XP hibernation settings in the Power Options applet

• **Figure 26.36**   Keys for adjusting screen brightness

Figure 26.36 shows a close-up of the FN-activated keys for adjusting screen brightness.

One of the best ways to conserve battery use is to plan ahead for times when you'll be unplugged. When I travel, for example, and know that I'm going to need a certain set of files stored on my file server at the office, I put those files on my laptop before I leave, while it's still plugged into the AC. It's tempting to throw the files on a thumb drive so I don't have to break out my laptop at the office, right? Or to let Dropbox do my syncing for me when I get to a Wi-Fi hotspot, but both USB and Wi-Fi use electricity.

Better than that even, Windows Vista and Windows 7 enable me to designate the files and folders I need as **offline files**, storing a local, duplicate copy of the files and folders on my hard drive. When I connect my laptop into my office network, those offline files are automatically synced with the files and folders on the file server. Anything I changed on the laptop gets written to the server. Anything anyone changed in those folders on the server gets written to my laptop. (If changes were made on both sides, a sync conflict pops up automatically, enabling you to resolve problems without fear of overwriting anything important.)

To designate a folder and its contents as offline files, right-click on the folder you want and select *Always available offline* from the menu (see Figure 26.37). The sync will occur and you're done. When you want to open the files offline, go to the Control Panel and open the Sync Center applet (see Figure 26.38). Click the *Manage offline files* link in the Tasks list to open the Offline Files dialog box (see Figure 26.39). Click the *View your offline files* button and you're in.
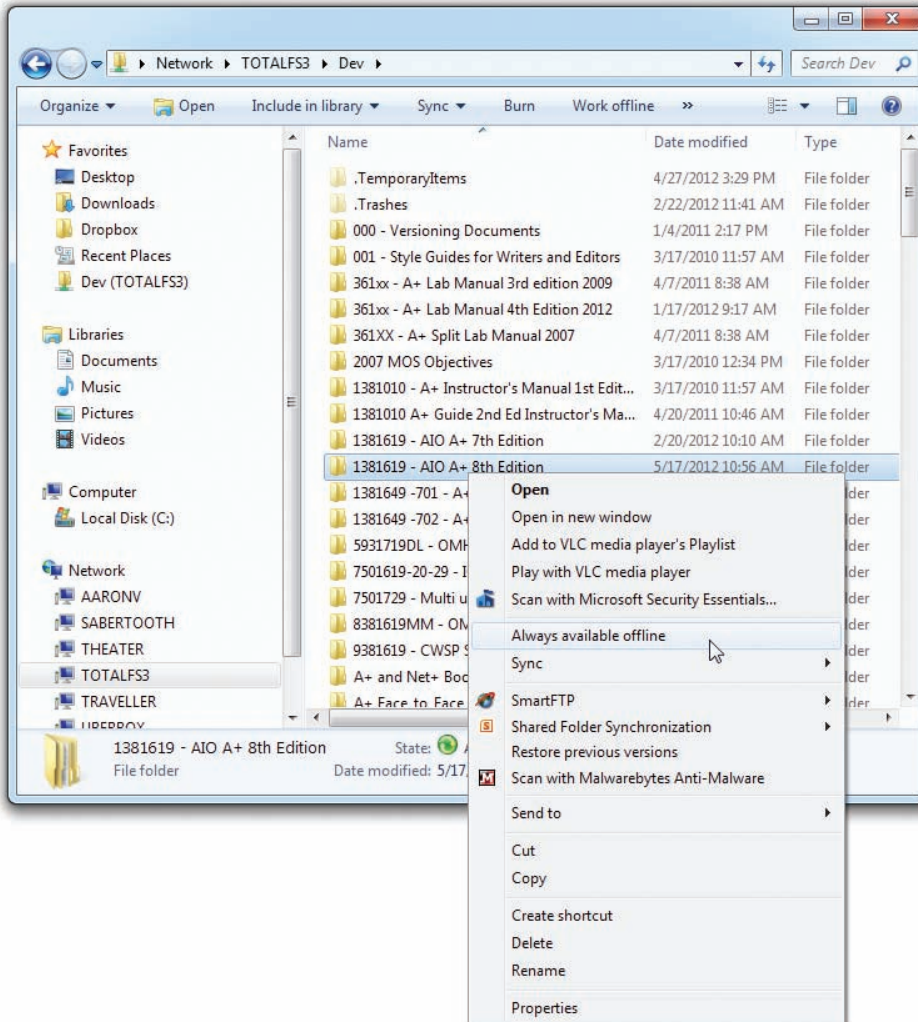
• **Figure 26.37**   Setting up offline files
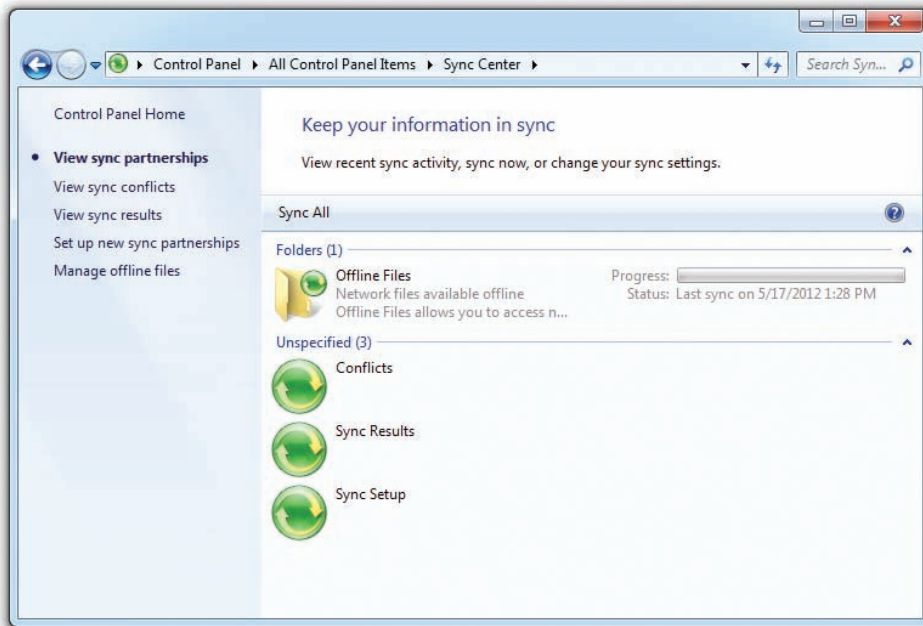
• Figure 26.38   Sync Center applet
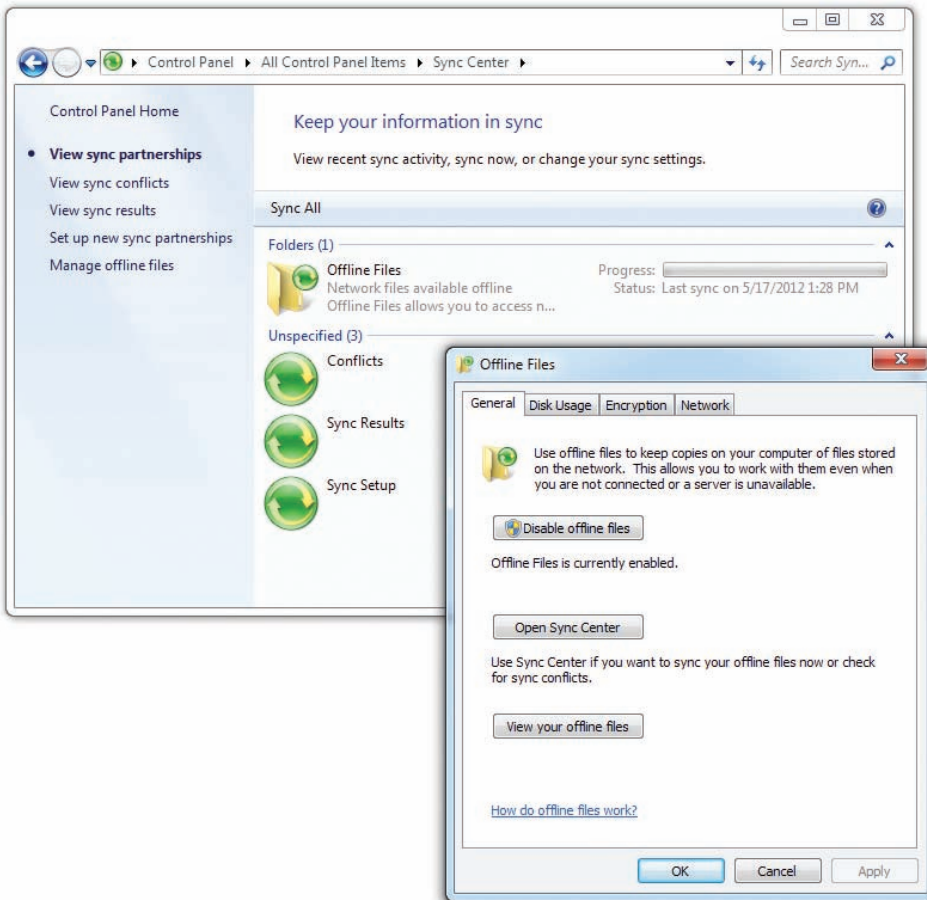
• Figure 26.39   Offline Files dialog box

Cleaning

Most portable PCs take substantially more abuse than a corresponding desktop model. Constant handling, travel, airport food on the run, and so on can radically shorten the life of a portable if you don't take action. One of the most important things you should do is clean the laptop regularly. Use an appropriate screen cleaner (not a glass cleaner!) to remove fingerprints and dust from the fragile LCD panel. (Refer to Chapter 21 for specifics.)

If you've had the laptop in a smoky or dusty environment where the air quality alone causes problems, try cleaning it with compressed air. Compressed air works great for blowing out the dust and crumbs from the keyboard and for keeping PC Card sockets clear. Don't use water on your keyboard! Even a minor amount of moisture inside the portable can toast a component.

Heat

To manage and maintain a healthy portable PC, you need to deal with issues of heat. Every portable has a stack of electronic components crammed into a very small space. Unlike their desktop brethren, portables don't have lots of freely moving air space that enables fans to cool everything down. Even with lots of low-power-consumption devices inside, portable PCs crank out a good deal of heat. Excessive heat can cause system lockups and hardware failures, so you should handle the issue wisely. Try this as a starter guide:

- Use power management, even if you're plugged into the AC outlet. This is especially important if you're working in a warm (more than 80 degrees Fahrenheit) room.
- Keep air space between the bottom of the laptop and the surface on which it rests. Putting a laptop on a soft surface, such as a pillow on your lap, creates a great heat-retention system—not a good thing! Always use a hard, flat surface.
- Don't use a keyboard protector for extended amounts of time.
- Listen to your fan, assuming the laptop has one. If it's often running very fast—you can tell by the high-pitched whirring sound— examine your power management settings and your environment, and change whatever is causing heat retention.
- Speaking of fans, be alert to a fan that suddenly goes silent. Fans do fail on laptops, causing overheating and failure. All laptop fans can be replaced easily.

Protecting the Machine

Although prices continue to drop for basic laptops, a fully loaded system is still pricey. To protect your investment, you'll want to adhere to certain best practices. You've already read tips in this chapter to deal with cleaning and heat, so let's look at the "portable" part of portable computers.

Tripping

Pay attention to where you run the power cord when you plug in a laptop. One of the primary causes of laptop destruction is people tripping over the power cord and knocking the laptop off of a desk. This is especially true if you plug in at a public place such as a café or airport. Remember, the life you save could be your portable PC's!

Storage

If you aren't going to use your laptop for a while, storing it safely will go a long way toward keeping it operable when you do power it up again. Investing in a quality case is worth the extra few dollars—preferably one with ample padding. Not only will this protect your system on a daily basis when transporting it from home to office, but it will keep dust and pet hair away as well. Lastly, protect from battery leakage by removing the battery if you'll be storing your device for an extended time.

Travel

If you're traveling with a laptop, take care to guard against theft. If possible, use a case that doesn't look like a computer case. A well-padded backpack makes a great travel bag for a laptop and appears less tempting to would-be thieves. Don't forget to pack any accessories you might need, like modular devices, spare batteries, and AC adapters. Make sure to remove any disks, such as optical or floppies, from their drives. Most importantly—back up any important data before you leave!

Make sure to have at least a little battery power available. Heightened security at airports means you might have to power on your system to prove it's really a computer and not a transport case for questionable materials. And never let your laptop out of your sight. If going through an x-ray machine, request a manual search. The x-ray won't harm your computer like a metal detector would, but if the laptop gets through the line at security before you do, someone else might walk away with it. If flying, stow your laptop under the seat in front of you where you can keep an eye on it.

If you travel to a foreign country, be very careful about the electricity. North America uses ~115-V power outlets, but most of the world uses ~230-V outlets. Many portable computers have **auto-switching power supplies**, meaning they detect the voltage at the outlet and adjust accordingly. For these portables, a simple plug converter will do the trick. Other portable computers, however, have *fixed-input power supplies*, which means they run only on ~115-V or on ~230-V power. For these portables, you need a full-blown electricity converting device, either a step-down or step-up *transformer*. You can find converters and transformers at electrical parts stores, such as Radio Shack in the United States.
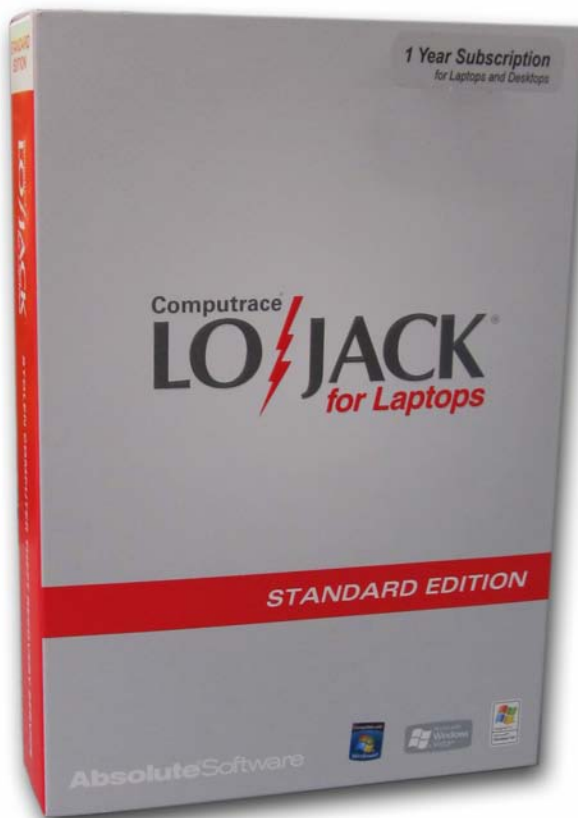
Shipping

Much of the storage and travel advice can be applied to shipping. Remove batteries and optical discs from their drives. Pack the laptop well and disguise the container as best you can. Back up any data and verify the warranty coverage. Ship with a reputable carrier and always request a tracking

• **Figure 26.40**   Cable lock

• **Figure 26.41**   LoJack (photo courtesy of Absolute Software Corporation)

number and, if possible, delivery signature. It's also worth the extra couple of bucks to pay for the shipping insurance. And when the clerk asks what's in the box, it's safer to say "electronics" rather than "a new 20-inch laptop computer."

Security

The fact is, if someone really wants to steal your laptop, they'll find a way. There are, however, some things you can do to make yourself, and your equipment, less desirable targets. As you've already learned, disguise is a good idea. Although you don't need to camouflage your laptop or carry it in a brown grocery bag on a daily basis, an inconspicuous carrying case will draw less attention.

Another physical deterrent is a laptop lock. Similar to a steel bicycle cable, there is a loop on one end and a lock on the other. The idea is to loop the cable around a solid object, such as a bed frame, and secure the lock to the small security hole on the side of the laptop (see Figure 26.40). Again, if someone really wants to steal your computer, they'll find a way. They'll dismantle the bed frame if they're desperate. The best protection is to be vigilant and not let the computer out of your sight.

An alternative to physically securing a laptop with a lock is to use a software tracking system. Software makers, such as Computer Security Products, Inc., at www.computersecurity.com, offer tracking software that transmits a signal to a central office if the computer is stolen and connected to a phone line or the Internet. Even LoJack, the company famous for recovering stolen automobiles via its tracking devices, lends its name to a tracking product sold by Absolute Software (see Figure 26.41). The location of the stolen PC can be tracked, and sensitive files can even be deleted automatically with the aid of the stealth signal.

Mike Meyer's CompTIA A+ Guide to Managing and Troubleshooting PCs

■ Upgrading and Repairing Laptop Computers

A competent tech can upgrade and repair portable computers to a degree, though true laptop techs are specialists. Upgrading the basics usually means breaking out the trusty screwdriver and avoiding electrostatic discharge (ESD). *Repairing* portables successfully, on the other hand, requires research, patience, organization, special tools, and documentation. Plus you need a ridiculously steady hand. This section provides an overview of the upgrade and repair process.
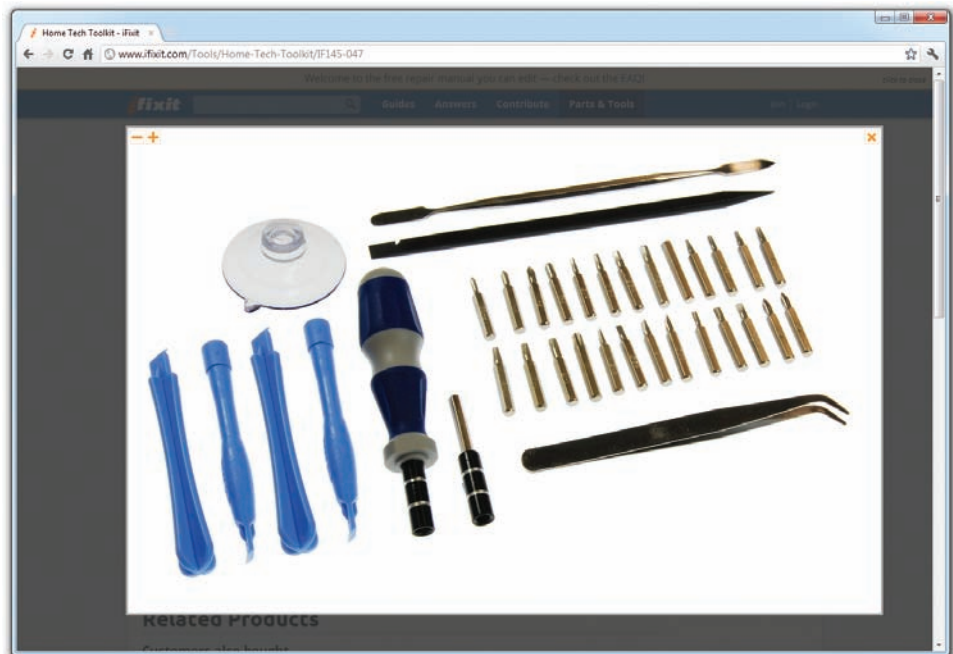
Disassembly Process

Disassembling a portable PC is pretty easy. Putting it back together in working condition is the hard part! You need to follow a four-step process to succeed in disassembly/reassembly.

First, *document and label every cable and screw location*. Laptops don't use standard connectors or screws. Often you'll run into many tiny screws of varying threads. If you try to put a screw into the wrong hole, you could end up stripping the screw, stripping the hole, or getting the screw wedged into the wrong place.

Second, *organize any parts you extract from the laptop*. Seriously, put a big white piece of construction paper on your work surface, lay each extracted piece out in logical fashion, and clearly mark where each component connects and what it connects to as well.

Third, *refer to the manufacturer's documentation*. I can't stress this point enough. Unlike desktop PCs, portable PCs have no standardization of internal structure. Everything in the portable is designed according to the manufacturer's best engineering efforts. Two portables from the same manufacturer might have a similar layout inside, but it's far more likely that every model differs a lot.

Finally, you need to *use the appropriate hand tools*. A portable PC, especially on the inside, will have a remarkable variety of tiny screws that you can't remove/reinsert without tiny-headed Phillips or Torx drivers. You'll need tiny pry bars—metal and plastic—to open components. Figure 26.42 shows an entry-level toolkit for a laptop tech that you can order from iFixit.com

• **Figure 26.42**   Bare-minimum laptop repair tools

(more on this site in a moment). Their professional version of the toolkit has 70 tools, plus there's an expansion kit! Like I said at the beginning of the chapter, portable techs are specialists.
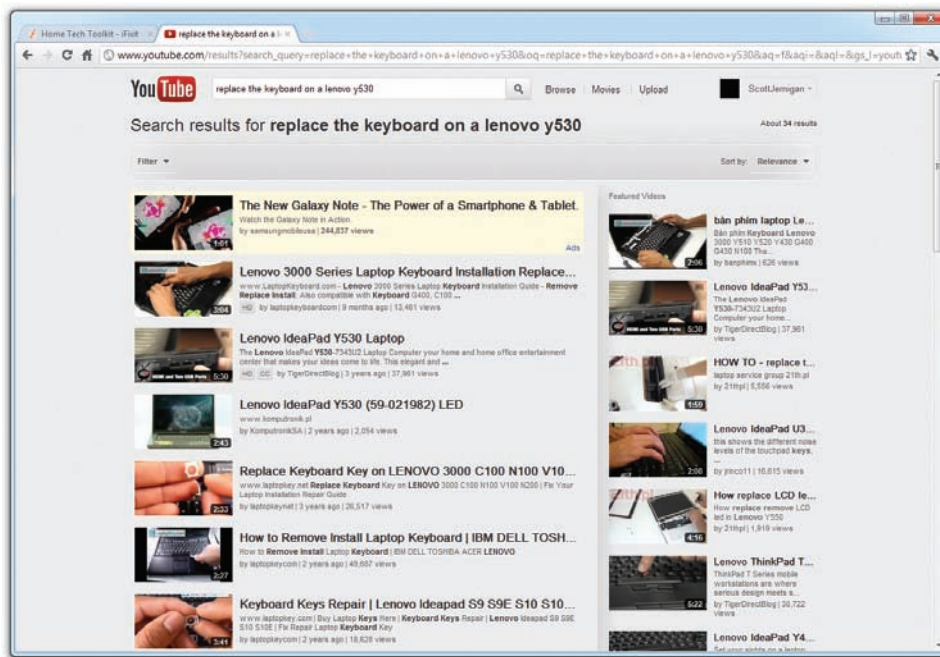
Now that you have the official line on the disassembly process, let's get one thing clear: A lot of manufacturers don't provide documentation to just any tech, but only to authorized repair centers. So what do you do when faced with an unfamiliar laptop that a client brought in for repair?

You have essentially three options. First, you can find a dedicated laptop tech and refer your client to that person. If the problem is exceptionally complicated and the portable in question is mission critical, that's often the best option. If you want to tackle the problem or it looks like something you should be able to do, then you go to the sources: YouTube and iFixit.com.

Every portable computer has a specific make and model. Open up a Web browser and go to YouTube. Type in precisely what you want to do, such as "replace the keyboard on a Lenovo y530," and see what pops up (see Figure 26.43). You'll most likely be in shock and awe when you get the results back, especially if the laptop in question is a couple of years old. People all over the world have to deal with broken devices, so you're not alone.

Once you've found the appropriate video or something that's close enough to enable the repair attempt, watch it. If it's too difficult for your skill level or requires a set of expensive tools, then fall back to step one and go find that dedicated tech. Otherwise, figure out what tools and parts you need. Parts specific to a laptop (as in that Lenovo keyboard in the preceding example) will need to be purchased from the manufacturer. More generic parts, like hard drives, CPUs, and so on, can be purchased from Newegg (my favorite tech store) or some other online retailer.

• Figure 26.43   YouTube search result

For general tools, parts, and a lot of very detailed step-by-step instructions, I highly recommend iFixit.com. Billed as a "free repair manual you can edit," iFixit is built by techs like you who conquer a problem, document the steps, and post the details (see Figure 26.44). This means the next tech along who runs into the same problem doesn't have to reinvent the wheel. Just go to iFixit.com. The proceeds from parts and tools they sell, by the way, go toward supporting the site. It's not a for-profit enterprise.
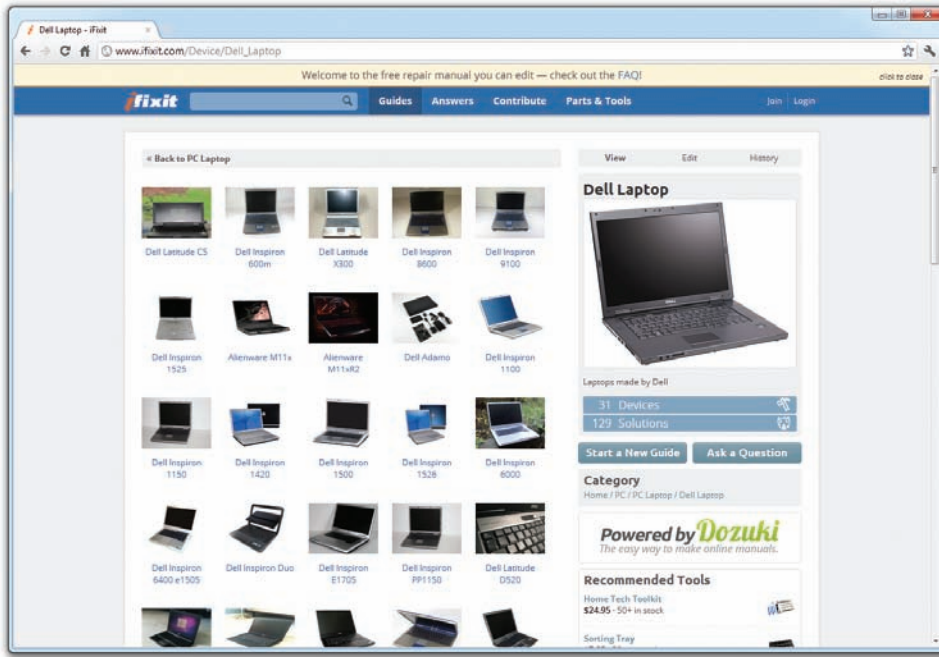
• Figure 26.44   Some of the Dell laptop repair walkthroughs at iFixit.com

Standard Upgrades

Every CompTIA A+ tech should know how to perform the two standard upgrades to portable computers: adding RAM and replacing a hard drive. Let's go through the steps.

RAM

Stock factory portable PCs almost always come with a minimal amount of RAM, so one of the first laptop upgrades you'll be called on to do is to add more RAM. Economy laptops running Windows 7 Home Premium routinely sit on store shelves and go home to consumers with as little as 1 GB of RAM, an amount guaranteed to limit the use and performance of the laptop. The OS alone will consume more than half of the RAM! Luckily, every decent laptop has upgradeable RAM slots. Ancient laptops use either 72-pin or 144-pin SO-DIMMs with SDRAM technology. DDR, DDR2, and DDR3 systems primarily use 200-pin SO-DIMMs (see Figure 26.45), although some laptops use micro-DIMMs.

How to Add or Replace RAM   Upgrading the RAM in a portable PC requires a couple of steps. First, you need to get the correct RAM. Many older portable PCs use proprietary RAM solutions, which means you need to order directly from Dell, HP, or Sony and pay exorbitant prices for the precious extra megabytes. Most manufacturers have taken pity on consumers in recent years and use standard SO-DIMMs or

One of the most striking contrasts between portable PCs and the tablets and smartphones you'll read about in Chapter 27 is in upgradability. You can and should upgrade portable PCs. Mobile devices, on the other hand, offer almost no upgradability at all.
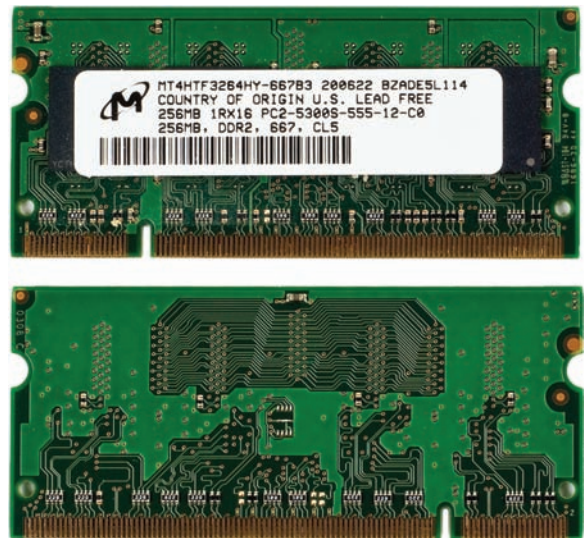
• Figure 26.45   200-pin SO-DIMM stick (front and back)

micro-DIMMs. Refer to the manufacturer's Web site or to the manual (if any) that came with the portable for the specific RAM needed.

Second, every portable PC offers a unique challenge to the tech who wants to upgrade the RAM, because there's no standard location for RAM placement in portables. More often than not, you need to unscrew or pop open a panel on the underside of the portable (see Figure 26.46). Then you press out on the restraining clips and the RAM stick pops up (see Figure 26.47). Gently remove the old stick of RAM and insert the new one by reversing the steps.

Always remove all electrical power from the laptop before removing or inserting memory. Disconnect the AC cord from the wall outlet. Take out the battery! Failure to disconnect from power can result in a fried laptop.

Shared Memory   Some laptops (and desktops) support **shared memory**. Shared memory reduces the cost of video cards by reducing the amount

• **Figure 26.46**   Removing a RAM panel

• **Figure 26.47**   Releasing the RAM

of memory on the video card itself. Instead of having 256 MB of RAM, the video card might have only 64 MB of RAM but be able to borrow 192 MB of RAM from the system. This equates to a 256 MB video card. The video card uses regular system RAM to make up for the loss.

The obvious benefit of shared memory is a less expensive video card (and a less expensive laptop!) with performance comparable to its mega-memory alternative. The downside is that your overall system performance will suffer because a portion of the system RAM is no longer available to programs. (The term *shared* is a bit misleading because the video card takes control of a portion of RAM. The video portion of system RAM is *not* shared back and forth between the video card processor and the CPU.) Shared memory technologies include TurboCache (developed by NVIDIA) and HyperMemory (developed by ATI).

Some systems give you control over the amount of shared memory, while others simply allow you to turn shared memory on or off. The settings are found in CMOS setup and only on systems that support shared memory. Shared memory is not reported to Windows, so don't panic if you have 1 GB of RAM in your laptop but Windows only sees 924 MB—the missing memory is used for video.

Adding more system RAM to a laptop with shared memory will improve laptop performance. Although it might appear to improve video performance, that doesn't tell the true story. It'll improve overall performance because the OS and CPU get more usable RAM. On some laptops, you can improve video performance as well, but that depends on the CMOS setup. If the shared memory is not set to maximum by default, increasing the overall memory and upping the portion reserved for video will improve video performance specifically.

> You cannot tell if a laptop is using shared memory in Windows. You have to go to CMOS to be sure.

HDD/SSD

You can replace a hard disk drive (HDD) or solid-state drive (SSD) in a portable PC fairly easily, especially if the laptop is only a few years old. SATA drives in the 2.5-inch drive format now rule in all laptops. Although much smaller than regular 3.5-inch hard drives, they use all the same features and configurations. These smaller hard drives have suffered, however, from diminished storage capacity as compared to their 3.5-inch brothers. Currently, large 2.5-inch hard drives hold up to 1 TB, while the 3.5-inch hard drives can hold more than 3 TB of data!

If you have a much older laptop, it might have a PATA drive, which means you need to pay more attention to cabling and jumpers. Some PATA drive manufacturers may require you to set the drive to use a cable-select setting as opposed to master or slave, so check with the laptop maker for any special issues. Otherwise, no difference exists between 2.5-inch drives and their larger 3.5-inch brethren (see Figure 26.48).

One of the best upgrades you can make on a laptop is to go from an HDD to an SSD. Obviously, you'll get a lot less storage capacity for the money, but the trade-offs can be worth it. First, the SSD will use a lot less electricity than an HDD, thus extending battery life. Second, any SSD is rip-roaringly faster than an HDD and performance across the board will be boosted.

• **Figure 26.48**   The 2.5-inch and 3.5-inch drives are mostly the same.

• Figure 26.49   Removing the drive compartment cover

• Figure 26.50   Inserting a replacement drive

The process of replacing a hard drive mirrors that of replacing RAM. You find the hard drive hatch—either along one edge or in a compartment on the underside of the computer—and release the screws (see Figure 26.49). Remove the old drive and then slide the new drive into its place (see Figure 26.50). Reattach the hatch or cover and boot the computer. Grab a Windows disc and prepare to reinstall.

Hardware Replacement

Once you get beyond upgrading RAM and replacing a hard drive on a portable PC, you take the plunge into the laptop repair specialty. You can replace some components by lifting them out, detaching a ribbon cable, and then reversing the steps with the replacement part. Other parts require a full teardown of the laptop to the bare bones, which presents a much greater magnitude of difficulty. Because every portable PC differs from every other one, this section provides guidance, but not concrete steps, for replacement.

Components

Replaceable components require more work than the RAM or drive upgrades, but replacing them generally falls into the category of "doable." What I call *components* are the battery, keyboard, optical drive, internal speaker, and plastic parts.

Battery If a battery's performance falls below an acceptable level, you can replace it with a battery from the manufacturer or from an aftermarket vendor. Although this should be a simple swap replacement (and usually is), you might encounter a situation where

the real problem wasn't the battery per se, but an inadequate or malfunctioning charging system. The new battery might not give you any better performance than the old one. Try it.

Keyboard   Getting a keyboard off a laptop computer often requires little pry bars, but also look for screws, clips, and so on. Keyboards connect via a tiny, short, and very delicate cable, often held down by tape. Replacing one is tricky, but doable.

Optical Drive   Replacing an optical drive can present a challenge. If the drive is part of a modular system, just pop out the old drive and pop in a new one. If the drive is part of the internal chassis of the portable, on the other hand, you're looking at a full dissection. (See the "Integral Parts" section for tips on dismantling the portable.)

Speaker   Like the optical drive, replacing the internal speaker or speakers on a laptop can be simple or a total pain, depending on where the speakers connect. Some laptops have speakers mounted on the outside of the chassis. You pry off the covers, pull out the little speakers, disconnect the cable, and then reverse the process for replacement speakers. If the speakers are inside the chassis, on the other hand, you need to dismantle the portable to get to them. (See the "Integral Parts" section.)

Plastic Parts   Laptops have a few plastic parts that can get lost or broken. These are slot covers or card blanks designed to keep dust out of the memory card and expansion slots (see Figure 26.51). If you need to replace one of these, simply get a spare from the manufacturer or an aftermarket vendor and replace it.

Expansion Cards   Not to be confused with PC Cards, many portable PCs have one or more true expansion slots for add-on cards. The more modular varieties will have a hatch on the bottom of the case that opens like the RAM hatch that gives you access to the slot(s). This enables you to change out an 802.11g wireless card, for example, for an 802.11n card, thus greatly
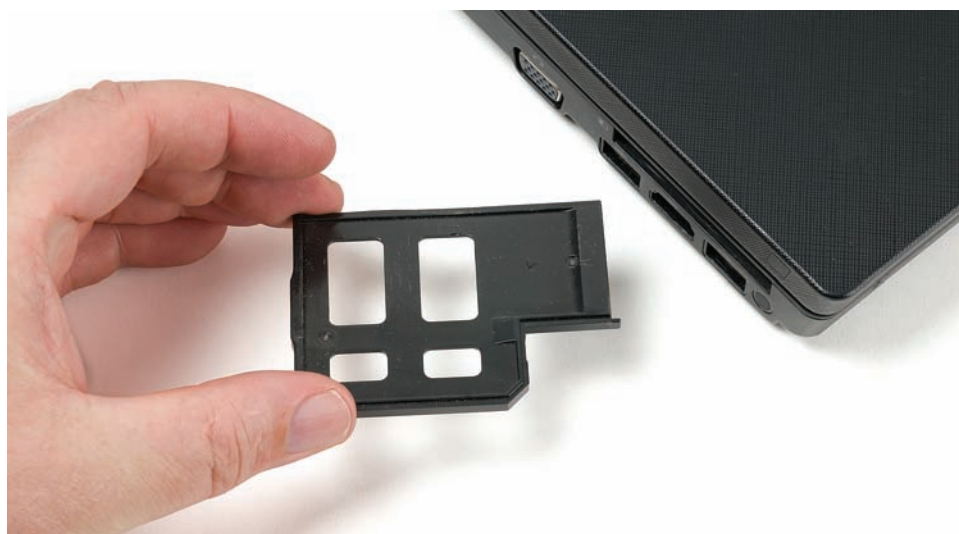
• **Figure 26.51**   ExpressCard blank

enhancing the Wi-Fi experience on this device. Figure 26.52 shows a wide-open laptop with the expansion slot exposed.

Just like when installing RAM in a portable, you must avoid ESD and remove all electricity before you take out or put in an expansion card. Failure to remove the battery and the AC adapter can and probably will result in a shorted-out laptop motherboard, and that just makes for a bad day.

The only other consideration with expansion cards applies specifically to wireless. Not only will you need to connect the card to the slot properly, but you must reattach the antenna connection and often a separate power cable. Pay attention when you remove the card as to the placement of these vital connections.

You'll find one of two types of expansion slot in a portable. The older ones (think 2005 and earlier) use **Mini-PCI**, because PCI dominated that time period. Just about every portable since then uses PCI Express, so the laptops come with **Mini-PCIe** slots.

CPU   Replacing a CPU on a modern portable takes a lot more work than replacing RAM or a Mini-PCIe expansion card, but follows the same general steps. Many CPUs mount facing the bottom of the portable, so that the venting goes away from your hands. When sitting properly on a flat surface, the heated air also goes to the back of the laptop and not toward the user. You access the CPU in this sort of system from the bottom of the portable.

As you can see in Figure 26.53, the CPU has an elaborate heat-sink and fan assembly that includes both the CPU and the chipset. Each of the pieces screws down in multiple places, plus the fan has a power connection. Aside from the tiny screws, there's no difference here in process between replacing a mobile CPU and a desktop CPU that you learned way back in Chapter 6.

First, remove all power from the laptop, including the battery. Remove the hatch to expose the CPU. Remove the heat-sink and fan assembly and lift out the CPU. Replace it with another CPU, apply thermal paste, and reattach the heat-sink and fan assembly. Reconnect the fan power connector and you're good to go.

• **Figure 26.52**   Mini-PCIe expansion slot on laptop

Figure 26.53 CPU heat-sink and fan assembly exposed

Some older laptops use passive cooling and thus have the CPU pointed up rather than down. They have a heat sink beneath the keyboard that cools everything down. With that style laptop, you remove the keyboard and heat sink to expose the CPU.

Integral Parts

Some hardware replacements require you to get serious with the laptop, opening it fully to the outside, removing many delicate parts, and even stripping it down to the bare metal chassis. I leave these repairs to the professional laptop repair folks, simply because they have the specific tools and expertise to do the job efficiently. CompTIA expects you to understand the process, though, so I've outlined it here. This pertains to four components: screen, DC jack, touchpad, and system board.

Portables open in two different ways, depending on the manufacturer. You either peel away layers from the top down, through the keyboard, or from the bottom up, through the base. Either direction requires careful attention to detail, part connectivity, and locations. You'll need a system to keep track of the dozens of tiny screws.

Every one of the replacements here requires you to detach the screen from the main chassis of the portable. Aside from finding the connection points and removing the proper screws, you need to pay attention to the connection points for the data stream to the monitor and the antenna that's in the frame of the display.

Once you have the portable stripped down, you replace whichever component you're in there to replace and then begin the process of building it back up into a coherent unit. Pay incredibly careful attention to getting data cables connected properly as you rebuild. I can't imagine a worse tech experience than replacing a touchpad and rebuilding a laptop only to have missed a connection and having to do it all over again.

The DC jack requires extra-special love when you need to replace one. The part is soldered to the main board, so to replace it means you'll need to not only strip the laptop to the bare metal, but also unsolder the old part and solder the new part. Then you'll rebuild the laptop and hope you got everything right. CompTIA cannot expect a CompTIA A+ technician to know how to do this stuff. Expect a question that explores whether it *can* be done. Rest assured, specialized techs can replace *any* component on a laptop, even the DC jack.

■ Troubleshooting Portable Computers

Many of the troubleshooting techniques you learned about for desktop systems can be applied to laptops. For example, take the proper precautions before and during disassembly. Use the proper hand tools, and document, label, and organize each plastic part and screw location for reassembly. Additionally, here are some laptop-specific procedures to try.

Laptop Won't Power On

- Verify AC power by plugging another electronic device into the wall outlet. If the other device receives power, the outlet is good.
- If the outlet is good, connect the laptop to the wall outlet and try to power on. If no LEDs light up, you may have a bad AC adapter. Swap it out with a known-good power adapter.
- A faulty peripheral device might keep the laptop from powering up. Remove any peripherals such as USB or FireWire devices.

Screen Doesn't Come On Properly

- If the laptop is booting (you hear the beeps and the drives), first make sure the display is turned on. Press the FN key and the key to activate the screen a number of times until the laptop display comes on. If that doesn't work, check the LCD cutoff switch—on many laptops, this is the small nub somewhere near the screen hinge that shuts the monitor off when you close the laptop—and make sure it isn't stuck in the down position.
- If the laptop display is very dim, you may have lost an inverter. The clue here is that inverters never go quietly. They can make a nasty hum as they are about to die and an equally nasty popping noise when they actually fail. Failure often occurs when you plug in the laptop's AC adapter, as the inverters take power directly from the AC adapter. It's also possible that the backlights in the LCD panel have died, though this is much less common than a bad inverter.
- If the screen won't come on or is cracked, most laptops have a port for plugging in an external monitor, which you can use to log into your laptop.
- If you plug a laptop into an external monitor and that monitor does not display, remember that you have both a hardware and an OS component to making dual displays successful. There's usually a combination of FN and another key to toggle among only portable, only external, and both displays. Plus you have the Display applet in the Control Panel to mirror or extend the desktop to a second monitor.

> **Tech Tip**
>
> **Battery Won't Charge**
>
> *If you have a laptop with a battery that won't charge up, it could be one of two things: the battery might be cooked or the AC adapter isn't doing its job. To troubleshoot, replace the battery with a known-good battery. If the new battery works, you've found the problem. Just replace the battery. Alternatively, remove the battery and run the laptop on AC only. If that works, you know the AC adapter is good. If it doesn't, replace the AC adapter.*

- Many manufacturers have switched to LED displays on laptops, which has led to a phenomenon many techs thought long behind us: *flickering displays*. The LED backlights don't work quite the same as CCFL backlights, especially when you lower the brightness. This doesn't affect desktop LED displays, because they're usually so bright it doesn't matter. But portables need to be able to dim to save battery life. One technique for dimming LEDs is to have them turn on and off rapidly enough to keep the pixels lit, but slowly enough that there's a reduction in visible light and electricity use. With some of these panels, that flickering is not only noticeable, but headache and eyestrain inducing.

- There are two things you can do with a flickering LED display: crank up the brightness so that it goes away (and thus live with reduced battery life) or replace the laptop.

Wireless Doesn't Work or Works Intermittently

- If the wireless doesn't work at all, check along the front, rear, or side edges of the laptop for a physical switch that toggles the internal wireless adapter or Bluetooth adapter on and off.

- If a tech has recently replaced a component that required removal of the laptop display, dead wireless could mean simply a disconnected antenna. Most portables have the antenna built into the display panel, so check that connection.

- Try the special key combination for your laptop to toggle the wireless or Bluetooth adapter. You usually press the FN key in combination with another key.

- You might simply be out of range or, if the wireless works intermittently, then right at the edge of the range. Physically walk the laptop over to the wireless router or access point to ensure there are no out-of-range issues.

- With Bluetooth specifically, remember that the pairing process takes action or configuration on both devices to succeed. Turn on the Bluetooth device, actively seek it, and try again.

Input Problems

- If none of the keys work on your laptop, there's a good chance you've unseated the keypad connector. These connectors are quite fragile and are prone to unseating from any physical stress on the laptop. Check the manufacturer's disassembly procedures to locate and reseat the keypad.

- If you're getting numbers when you're expecting to get letters, the number lock (NUMLOCK) function key is turned on. The numlock LED should indicate the status. Turn it off.

The troubleshooting issue known as a *ghost cursor* can mean one of two things. First, the display shows a trail of ghost cursors behind your real cursor as you move it. This might point to an aging display or an improperly configured refresh rate. Second, the cursor moves erratically, whether you are touching the touchpad or not. This probably means the touchpad has been damaged in some way and needs to be replaced.

- Laptop keyboards take far more abuse than the typical desktop keyboard, because of all those lunch meetings and café brainstorm sessions. Eating and drinking while over or around a keyboard just begs for problems. If you have a portable with sticking keys, look for the obvious debris in the keys. Use compressed air to clean them out. If you have serious goo and need to use a cleaning solution, disconnect the keyboard from the portable first. Make sure it's fully dried out before you reconnect it or you'll short it out.

- If the touchpad is having problems, a shot of compressed air does wonders for cleaning pet hair out of the touchpad sensors. You might get a cleaner shot if you remove the keyboard before using the compressed air. Remember to be gentle when lifting off the keyboard and make sure to follow the manufacturer's instructions.

- The touchpad driver might need to be reconfigured. Try the various options in the Control Panel | Mouse applet.

Chapter Review

■ Chapter Summary

After reading this chapter and completing the exercises, you should understand the following about portable computers.

Describe the many types of portable computing devices available

■ All portable devices share certain features: video output using LCD screens, some kind of PC sound, and DC battery power. There's no industry standard for naming the vast majority of styles of portable computing devices.

■ A portable PC refers in general to the clamshell, keyboard-on-the-bottom and LCD-screen-at-the-top design that is considered the shape of mobile PCs. The terms "laptop," "notebook," and "portable" all define the same form factor.

■ Portable computers come with a variety of input devices. Most have a fully functional keyboard and a device to control the mouse pointer. The basic QUERTY format is followed, but manufacturers make choices with key size and placement of the non-alphabet characters. Almost every portable keyboard uses a Function (FN) key to enable some keys to perform a third duty.

■ By far the most common laptop pointing device found today is the touchpad—a flat, touch-sensitive pad just in front of the keyboard. To operate a touchpad, you simply glide your finger across its surface to move the pointer, and tap the surface once or twice to single- or double-click.

■ Laptop LCD screens come in a variety of supported resolutions, described with acronyms such as XGA, WXGA, WSXGA, and more. The *W* in front of the letters indicates widescreen. The two most common resolutions are WXGA for the 14- to 15-inch models and HD 1080 for the 17.3-inch models. The common finish is either matte or high-gloss.

■ A portable PC can be considered a desktop replacement if it does everything most people want to do with a desktop PC. Desktop replacements appeal to road warriors and people who prefer to tuck computing devices out of sight when not in use.

■ Netbook portables normally weigh less than three pounds and are less than an inch in thickness. These machines usually have smaller displays, lower-capacity hard drives, and CPUs that operate at lower speeds than their more full-sized brethren.

■ Ultrabooks are for people who can't give up the power of high-end computers but can afford to pay more for a smaller package. Intel set up the Ultrabook specifications in 2011, defining the form factor to use power-sipping Intel processors with integrated graphics.

■ Microsoft started the Tablet PC initiative way back in 2001, defining the devices as fully featured portables running a tablet-aware version of Windows and using a stylus to interact directly with the screen. Many Tablet PCs have come to market since then, fulfilling the needs of specific professions, notably medicine.

Explain ways to expand portable computers

■ Every portable PC comes with one or more single-function ports. The most common of all is the ubiquitous USB port. Additionally, the single PS/2 port on some laptops supports both keyboards and pointing devices. Most portable computing devices have a speaker port, and some have line in and microphone jacks as well. Laptops invariably provide a video port such as a VGA, HDMI, DisplayPort, or DVI connection for hooking up an external monitor.

■ Most laptops support a second monitor, giving the user the option to display Windows on the laptop only, the external monitor only, or both simultaneously. Usually a special Function (FN) key on the keyboard will cycle through the monitor configurations.

■ All portables offer some kind of network connectivity, such as 802.11 Wi-Fi to connect to the Internet. Wired Ethernet ports are standard issue. Bluetooth is common for connecting peripherals. Portables have some way to toggle Wi-Fi and Bluetooth off and on to conserve battery life.

- PC Cards are roughly credit card–sized devices that enhance and extend the functions of a portable PC. Still commonly known by their older name, *PCMCIA cards*, PC Cards were standard on mobile computers for years but are slowly disappearing. All PC Cards are hot-swappable.

- Parallel PC Cards come in two flavors, 16-bit and CardBus, and each flavor comes in three different physical sizes, called Type I, Type II, and Type III. Type I, II, and III cards differ only in the thickness of the card (Type I being the thinnest and Type III the thickest). Type II cards are by far the most common. All parallel PC Cards share the same 68-pin interface. The 16-bit PC Cards are 16-bit, 5-V cards that can have up to two distinct functions or devices, such as a modem/network card combination. CardBus PC Cards are 32-bit, 3.3-V cards that can have up to eight different functions on a single card. The 16-bit PC Cards will fit into and work in CardBus slots, but the reverse is not true.

- The serial ExpressCard comes in two widths: 54 mm (ExpressCard/54) and 34 mm (ExpressCard/34). Both cards are 75 mm long and 5 mm thick, which makes them shorter than all previous PC Cards and the same thickness as a Type II PC Card. ExpressCards connect to either the Hi-Speed USB 2.0 bus (480 Mbps) or a PCI Express bus (2.5 Gbps).

- Most portable PCs have one or more general-purpose expansion ports that enable you to plug in many types of devices. Older portables sport RS-232 serial and IEEE 1284 parallel ports for mice, modems, printers, scanners, external CD-media drives, and more. USB, FireWire, and eSATA are popular and widespread methods for attaching peripherals to laptops. All have easy-to-use connectors and can be hot-swapped.

- Port replicators are devices that plug into a single port (usually USB but sometimes proprietary) and offer common PC ports, such as serial, parallel, USB, network, and PS/2. Docking stations resemble port replicators in many ways, offering legacy and modern single- and multi-function ports, but have extra features built in, such as optical drives or PC Card slots.

Manage and maintain portable computers

- Portable computers use three types of batteries: Nickel-Cadmium (Ni-Cd), Nickel-Metal Hydride (Ni-MH), and Lithium-Ion (Li-Ion). Today, only Li-Ion is used because that battery chemistry provides the highest energy density for the weight and has few problems with external factors.

- Batteries should be stored in a cool place and kept charged, at least to 70–80 percent. Never drain a battery all the way down unless required to do so as part of a battery calibration. Rechargeable batteries have only a limited number of charge-discharge cycles before overall battery performance is reduced. Because batteries contain dangerous chemicals, never handle one that has ruptured. Always recycle old batteries rather than disposing of them in the trash.

- The process of cooperation among the hardware, the BIOS, and the OS to reduce power use is known generically as power management. Early laptops used power continuously, regardless of whether the system was using the device at the time. With power management features, today's laptops can automatically turn off unused devices or can shut down the entire system, leaving the information in RAM ready for a restart. To perform these power management functions requires specialized hardware, BIOS, and an operating system that supports power management.

- Starting with the 386SX, Intel introduced System Management Mode (SMM), a power management system that would make the CPU and all peripherals go to "sleep." In 1992, Intel introduced the improved Advanced Power Management (APM) specification, followed by the Advanced Configuration and Power Interface (ACPI) standard in 1996.

- To use APM or ACPI, the computer must have an SMM-capable CPU, an APM-compliant BIOS, and devices that can be shut off. Referred to as Energy Star devices, these peripherals can shut down without actually turning off. The OS must also know how to request that a particular device be shut down. ACPI extends power-saving to include hot-swappable devices.

- Virtually all laptops and desktops use power management functions. APM defines four power-usage levels, including Full On, APM Enabled, APM Standby, and APM Suspend. ACPI, the successor to APM, handles all these levels plus a few more, totaling four Global (G) and six total (S) states. Support for APM was discontinued in Windows Vista, which uses ACPI.

- Configure APM/ACPI through CMOS or through the Power Options Control Panel applet in Windows, with Windows settings overriding CMOS settings. Many CMOS versions allow configuration of wake-up events.

- Hibernation writes information from RAM to the hard drive. Upon waking up, the data is returned to RAM, and programs and files are in the same state they were in when the computer entered hibernation.

- Laptops with backlit keyboards will have some way you can disable this feature when it's not needed, usually with a keyboard combination. You can also reduce the output of the LCD backlight using a combination of FN and another key to get a few more minutes of computing time before you have to shut down.

- Use an appropriate screen cleaner (not glass cleaner) to clean the LCD screen. Use compressed air around the keyboard and PC card sockets. Never use water around the keyboard.

- To combat the inevitable heat produced by a portable computer, always use power management, keep an air space between the bottom of the laptop and the surface on which it rests, don't use a keyboard protector for an extended period of time, and be aware of your fan.

- Store portable computers in quality cases when traveling. Well-padded backpacks not only keep a laptop protected but also make a system less appealing to would-be thieves. When traveling, don't forget accessories such as AC power cords, additional batteries, or modular devices. Remove all discs from drives and make sure you have enough battery power to boot up for security personnel. If shipping your computer, go with a reputable carrier, keep your tracking number, and request a delivery signature. Use a laptop lock or a software tracking system to protect your laptop when traveling.

Upgrade and repair portable computers

- You need to follow a four-step process to succeed in disassembly/reassembly. First, document and label every cable and screw location. Second, organize any parts you extract from the laptop. Third, refer to the manufacturer's documentation. Finally, you need to use the appropriate hand tools. If you can't get information directly from the manufacturer, try various online sites, such as YouTube or iFixit, for walkthroughs on fixing laptop problems.

- Every CompTIA A+ tech should know how to perform the two standard upgrades to portable computers: adding RAM and replacing a hard drive.

- Laptops use one of four types of RAM. Most older laptops use either 72-pin or 144-pin SO-DIMMs with SDRAM technology. DDR SDRAM systems primarily use 200-pin SO-DIMMs, although you'll also find 172-pin micro-DIMMs. Every decent laptop has upgradeable RAM slots. Get the correct RAM; many portable PC makers use proprietary RAM solutions. No standard exists for RAM placement in portables. More often than not, you need to unscrew or pop open a panel on the underside of the portable and press out on the restraining clips to make the RAM stick pop up so you can remove and replace it. Always disconnect from all electrical sources before removing or inserting RAM.

- Laptops that support shared memory benefit from more affordable video cards. The video card has less built-in RAM and uses a portion of the computer's system RAM to make up the difference. Although this results in a lower cost, system performance suffers because RAM that is shared with the video card is not available to programs. NVIDIA calls their shared memory technology TurboCache and ATI calls theirs HyperMemory.

- SATA drives in the 2.5-inch drive format now rule in all laptops. Currently, the larger 2.5-inch hard drives hold up to 500+ GB, while the larger 3.5-inch hard drives hold more than 3 TB. Upgrading from an HDD to an SSD can bring remarkable gains in battery life and performance.

- Once you get beyond upgrading RAM and replacing a hard drive on a portable PC, you take the plunge into the laptop repair specialty. You

can replace some components by lifting them out, detaching a ribbon cable, and then reversing the steps with the replacement part. Other parts require a full teardown of the laptop to the bare bones, which presents a much greater level of difficulty.

- Standard tech-level repairs you should be able to do are replacing the battery, keyboard, and optical drive (usually—some are tough to get out). Others are replacing the small speakers and missing plastic parts.

- You can also open the hatch on the bottom of the case that opens like the RAM hatch to expose other parts for replacement. The same hatch might hold one or two Mini-PCIe slots, for example, and give you access to the CPU.

- Some hardware replacements require you to open a laptop, remove many delicate parts, and strip it down to the bare metal chassis. Dedicated laptop techs do these jobs, but you should know the process.

- Portables open in two different ways, depending on the manufacturer. You either peel away layers from the top down, through the keyboard, or from the bottom up, through the base. Either direction requires careful attention to detail, part connectivity, and locations. You'll need a system to keep track of the dozens of tiny screws.

Troubleshoot portable computers

- If your laptop won't power on, try a different wall outlet. If it still fails to power up, remove all peripheral devices and try again.

- If the screen doesn't come on properly, verify that the laptop is configured to use the built-in LCD screen by pressing the appropriate key to cycle through the internal and external monitors. If you hear a popping sound, you may have blown an inverter. If the screen is definitely broken, you may use an external monitor to access the laptop. One technique for dimming LEDs is to have them turn on and off rapidly enough to keep the pixels lit, but slowly enough that there's a reduction in visible light and electricity use. With some of these panels, that flickering is not only noticeable, but headache and eyestrain inducing.

- If wireless is not working, check for the physical switch on the side of the laptop that toggles power to the internal network card or Bluetooth adapter. If your laptop doesn't have a switch, check for a key combination or function key that toggles power. You also may be out of range. Physically walk the laptop closer to the wireless router or access point.

- If the keypad or touchpad doesn't work, try a shot of compressed air, reseat the physical internal connection, or reconfigure the driver settings through the Control Panel.

■ Key Terms

16-bit (1000)
Advanced Configuration and Power Interface (ACPI) (1005)
Advanced Power Management (APM) (1005)
aspect ratio (989)
auto-switching power supply (1013)
CardBus (1000)
desktop replacement (990)
docking station (1003)
ExpressCard (1000)
Function (FN) key (987)
hibernation (1006)
high-gloss (990)
laptop (987)
Lithium-Ion (Li-Ion) (1003)

matte (990)
Mini-PCI (1022)
Mini-PCIe (1022)
multitouch (989)
netbook (991)
Nickel-Cadmium (Ni-Cd) (1003)
Nickel-Metal Hydride (Ni-MH) (1003)
notebook (987)
offline files (1010)
PC Card (999)
PCMCIA card (1000)
port replicator (1002)
power plan (1008)
shared memory (1018)
sleep timer (1008)

stylus *(992)*
System Management Mode (SMM) *(1005)*
Tablet PC *(992)*

touchpad *(989)*
TrackPoint *(988)*
Ultrabook *(992)*

■ Key Term Quiz

Use the Key Terms list to complete the sentences that follow. Not all terms will be used.

1. A typical clamshell-style computer with built-in LCD monitor, keyboard, and input device is most commonly called a laptop or _____.

2. The _____ enables laptop keyboards to do more than two functions on a single key.

3. Many newer laptops feature _____ screens offering richer color, higher contrast, and wider viewing angles.

4. Intel set up the _____ specifications for super thin, super light, and super efficient laptops with integrated graphics and no optical drive.

5. The _____ replaced the PC Card as the external expansion slot of choice on laptops.

6. A(n) _____ plugs into a single port on the portable computer and offers uncommon and common PC ports, such as serial, parallel, USB, network, and PS/2.

7. Today's laptops use _____ for batteries because that battery chemistry provides the highest energy density for the weight.

8. Windows Vista and Windows 7 enable _____ for storing and automatically syncing files and folders between a portable and a file server.

9. Laptops using _____ are less expensive because the video card has less built-in memory, but the RAM it borrows from the system results in less memory available to programs.

10. Most laptops today have one or more _____ slots for internal expansion cards such as Wi-Fi NICs.

■ Multiple-Choice Quiz

1. Which of the following statements best describes hard drives typically found in laptops?

    A. They are 2.5-inch SATA drives, but they do not hold as much data as the 3.5-inch hard drives found in desktop PCs.

    B. They are 3.5-inch ATA drives just like those found in desktop PCs, but they usually require "cable select" settings rather than master or slave.

    C. They are 3.5-inch SATA drives that hold more data than the 2.5-inch hard drives found in desktop PCs.

    D. They are 2.5-inch PCMCIA drives, while desktops usually have 3.5-inch SCSI drives.

2. Which of the following APM power levels writes information from RAM to the hard drive and then copies the data back to RAM when the computer is activated again?

    A. Full On

    B. APM Enabled

    C. APM Standby

    D. Hibernation

3. Portable PCs typically use which of the following kinds of upgradeable RAM?

    A. 68-pin and 72-pin RIMMs

    B. 30-pin and 72-pin SIMMs

    C. 72-pin and 144-pin SO-DIMMs

    D. 30-pin and 72-pin SO-RIMMs

4. Where do you configure APM/ACPI in Windows?

    A. The Power Options applet in the Control Panel

    B. The Display applet in the Control Panel

    C. The Power Management applet in the Control Panel

    D. The Power and Devices applet in the Control Panel

5. Which of the following input devices will you most likely find on a portable PC?

   A. TrackPoint

   B. Touchpad

   C. Trackball

   D. Mouse

6. Which buses do ExpressCards use?

   A. Hi-Speed USB and FireWire

   B. Hi-Speed USB and PCI Express

   C. PCI and PCI Express

   D. Mini-PCI and Parallel

7. *Convertibles* and *slates* describe what type of device?

   A. Multicore processor

   B. Clamshell laptop computer

   C. PDA

   D. Tablet PC

8. If wireless networking is not working, what should you check?

   A. Check the switch on the side of the laptop that toggles power to the network card.

   B. Make sure the Ethernet cable is plugged into the laptop.

   C. Make sure the digitizer has been trained.

   D. Make sure Power Management is enabled.

9. Erin has an older laptop with a switch on the back that says 115/230. What does this indicate?

   A. The laptop has an auto-switching power supply.

   B. The laptop has a fixed-input power supply.

   C. The laptop has a step-down transforming power supply.

   D. The laptop has a step-up transforming power supply.

10. Which of the following display types will you most commonly find on a portable PC today? (Select two.)

    A. LCD

    B. LED

    C. OLED

    D. Plasma

11. Jake has received two replacement memory sticks for his Dell laptop. What should he do first in the upgrade process?

    A. Disconnect the AC cord and remove the battery.

    B. Flip the laptop over and remove the RAM compartment cover.

    C. Remove the memory sticks from their antistatic bags and set them on the antistatic map next to the laptop.

    D. Remove the memory sticks from the laptop.

12. Steve complains that his Windows 7 laptop still isn't snappy enough after doubling the amount of RAM. What might improve system performance?

    A. Add more RAM.

    B. Replace the power supply.

    C. Replace the battery.

    D. Replace the HDD with an SSD.

13. Jim likes his laptop but complains that his wireless seems slow compared to all the new laptops. On further inspection, you determine his laptop runs 802.11g. What can be done to improve his network connection speed?

    A. Replace the regular RAM with 802.11n RAM.

    B. Replace the display with one with a better antenna.

    C. Replace the Mini-PCIe 802.11g card with an 802.11n card.

    D. Get a new laptop, because this one can't be upgraded.

14. Edgar successfully replaced the display on a laptop (a toddler had taken a ballpoint pen to it), but the customer called back almost immediately complaining that his wireless didn't work. What could the problem be?

    A. The problems are unrelated, so it could be anything.

    B. Edgar inadvertently disconnected the antenna from the Mini-PCIe 802.11 card.

    C. Edgar replaced the display with one without an internal antenna.

    D. Edgar failed to reconnect the antenna in the new display.

15. Rafael gets a tech call from a user with a brand new laptop complaining that working on it was causing headaches. What could the problem be?

   A. The laptop uses a plasma display.

   B. The laptop uses a CRT display.

   C. The laptop uses an LED display in power saving mode.

   D. The laptop uses an LED display in full power mode.

■ Essay Quiz

1. At the upcoming training seminar for new techs, your boss wants to make sure they understand and use power management settings. You've been asked to prepare a short presentation showing the range of power management settings available in Windows XP, Vista, and 7 and demonstrating how to set them. What will you include in your presentation?

2. You've been tasked to advise your group on current portable computer technology so they can purchase ten new laptops by the end of the quarter. In a short essay, weigh the pros and cons of getting desktop replacements versus smaller laptops that would come with docking stations.

3. Your boss has a new portable computer and is planning to take it with him on a business trip to Paris. He's not all that tech-savvy or much of a traveler, so write a memo that tells him what to do or avoid while traveling, especially overseas.

4. Norm wants to upgrade his laptop's hard drive, CPU, and RAM. Because he's upgraded all of these components on his desktop, he doesn't think he'll run into much trouble. What advice will you give him about selecting the components and upgrading the laptop?

Lab Projects

• Lab Project 26.1

This chapter mentioned that, although they are more expensive, portable PCs typically provide less processing power and smaller hard drives, and in general are not as full-featured as desktop computers. Use the Internet to check sites such as www.lenovo.com, www.toshiba.com, www.dell.com, and www.hp.com to compare the best equipped, most powerful laptop you can find with the best equipped, most powerful desktop computer you can find. How do their features and prices compare? Now find a less expensive laptop and try to find a desktop computer that is as similar as possible in terms of capabilities, and compare their prices.

• Lab Project 26.2

Continuing from the previous lab, go to the www.dell.com website and compare one of the better desktop-replacement laptops with one of the more basic laptops. List the features that are of interest to you personally, starting with the most important and continuing down. Then use the site to begin building the perfect laptop for you. Compare your results with others and discuss what's important to you.