CHAPTER 9

Installing and Supporting I/O Devices

In this chapter, you will learn:

- About the general approaches you need to take when installing and supporting I/O devices
- About the types of I/O devices and their characteristics
- How to install input devices, including the mouse, keyboard, barcode reader, fingerprint reader, and touch screen
- How to install and configure several I/O devices, including ports on the motherboard, dual monitors, and expansion cards
- How to troubleshoot I/O devices, including keyboards, pointing devices, and video

This chapter is packed full of details about the many I/O devices a PC support technician must be familiar with and must know how to install and support. We begin with looking at the features and characteristics of several input and output devices, including motherboard ports, display devices, and expansion cards. Then you'll learn how to install common peripherals, input devices, expansion cards, dual monitors, and multiple video cards. Troubleshooting is always an important skill for technicians, and so we end the chapter with a discussion of what can go wrong with I/O devices and how to identify the source of the problem and fix it. This chapter builds the foundation for Chapter 10, in which you will learn about multimedia devices.

BASIC PRINCIPLES TO SUPPORT I/O DEVICES

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An I/O device can be either internal (installed inside the computer case) or external (installed outside the case). Internal devices can be expansion cards inserted in expansion slots on the motherboard, such as a network card, sound card, video capture card, and video card. External devices include keyboards, monitors, mice, printers, scanners, digital cameras, and flash drives. You can connect an external device to the system using ports coming off the motherboard (serial, parallel, USB, IEEE 1394, and so forth), or a port can be provided by an expansion card.

In this chapter, you will learn a ton of information about these many I/O devices. However, for all these different devices, some basic principles apply to supporting each one of them. These principles are applied in numerous places throughout this chapter and are summarized here so you can get a first look at them. Consider these fundamental principles and concepts used when supporting I/O devices:

Video
Device with Bundled Software

- *Every I/O device is controlled by software*. When you install a new I/O device, such as a barcode reader, you must install both the device and the device drivers to control the device. These device drivers must be written for the OS you are using. Recall from earlier chapters that the exception to this principle is some simple devices, such as the keyboard, that are controlled by the system BIOS or device drivers embedded in the OS.
- *When it comes to installing or supporting a device, the manufacturer knows best*. In this chapter, you will learn a lot of principles and procedures for installing and supporting a device, but when you're on the job installing a device or fixing a broken one, read the manufacturer documentation and follow those guidelines first. For example, for most installations, you install the device before you install the device driver. However, for some devices, such as a digital camera and a wireless keyboard, you install the device driver first. Check the device documentation to know which to do first.
- *Some devices need application software to use the device*. For example, after you install a scanner and its device drivers, you might also need to install Adobe Photoshop to use the scanner.
- *Problems with a device can sometimes be solved by updating the device drivers or firmware*. Device manufacturers often release updates to device drivers. Update the drivers to solve problems with the device or to add new features. The firmware on the device might also need updating to solve a problem or add a new feature.
- *Learning about I/O devices is a moving target*. No matter how much information can be packed into this chapter, it won't be enough. I've done my best to make sure everything presented in this chapter is current, but I know that by the time this book is in print, some of the content will already be outdated. To stay abreast of all the latest technologies, an excellent source for information is the Internet. Use a good search engine to look up additional information about the I/O devices in this chapter and to learn about others. For the most reliable information about a device, see the manufacturer's Web site.
- *Devices and their device drivers are managed using Device Manager*. Device Manager is the primary Windows tool to manage hardware devices. When you first install a device, use Device Manager to verify that Windows recognizes the device with no errors. You can also use it to uninstall, enable, or disable a device and view any problems that Windows sees concerning the device. Device Manager is also the tool to use to update drivers for a

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device. Device drivers that Microsoft has certified to work with Windows are digitally signed by Microsoft. Digitally signed drivers are required for all 64-bit versions of Vista.

- *Some devices are expected to follow the Energy Star standards*. **Energy Star** systems and peripherals have the U.S. Green Star, indicating that they satisfy certain energy-conserving standards of the U.S. Environmental Protection Agency (EPA), sometimes called the Green Standards. Devices that can carry the Green Star include computers, monitors, printers, copiers, and fax machines.

Notes Office equipment is among the fastest growing source of electricity consumption in industrialized nations. Much of this electricity is wasted because people often leave computers and other equipment on overnight. Because Energy Star devices go into sleep mode when they are not used, they create overall energy savings of about 50 percent.

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know how to find and download a device driver.

APPLYING CONCEPTS

Suppose you have just borrowed an HP Photosmart 7760 Deskjet printer from a friend, but you forgot to borrow the CD with the printer drivers on it. Instead of going back to your friend's apartment, you can go to the Hewlett-Packard Web site (*www.hp.com*), download the drivers to a folder on your PC, and install the driver under Windows. Figure 9-1 shows a Web page from the site listing downloadable drivers for ink-jet printers. Be sure to download the drivers for the version of Windows you are using.

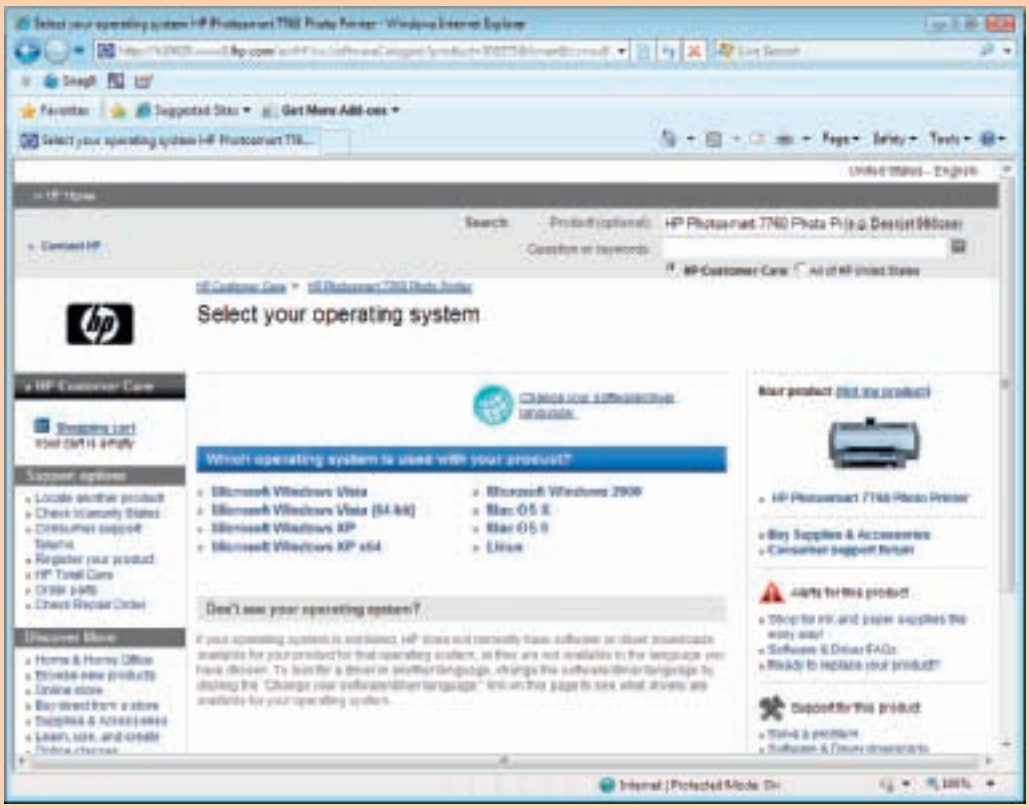

Figure 9-1 Download the latest device drivers from a manufacturer's Web site
Courtesy: Course Technology/Cengage Learning

We now turn our attention to the types and characteristics of I/O devices and peripherals for a PC.

TYPES AND FEATURES OF I/O DEVICES

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In this part of the chapter, you'll learn about the I/O ports on a motherboard, display devices, including a monitor, projector, and video card, and other expansion cards. Later in the chapter, you'll learn how to install, configure, and troubleshoot these devices.

I/O PORTS ON THE MOTHERBOARD

Devices can plug into a port that comes directly off the motherboard, such as a USB, FireWire (IEEE 1394), sound, video, PS/2, network, serial, or parallel port. Or a port such as an eSATA, FireWire, USB, parallel, serial, video, or SCSI port can be provided by an expansion card. In this section, you'll learn about the details of the serial, parallel, USB, and FireWire ports that come directly off a motherboard.

Figure 9-2 shows the ports on the rear of a computer case; some of them are provided by the motherboard and others are provided by an expansion card. When deciding what type of port a new device should use, the speed of the port is often a tiebreaker. Table 9-1 shows the speeds of various ports, from fastest to slowest.

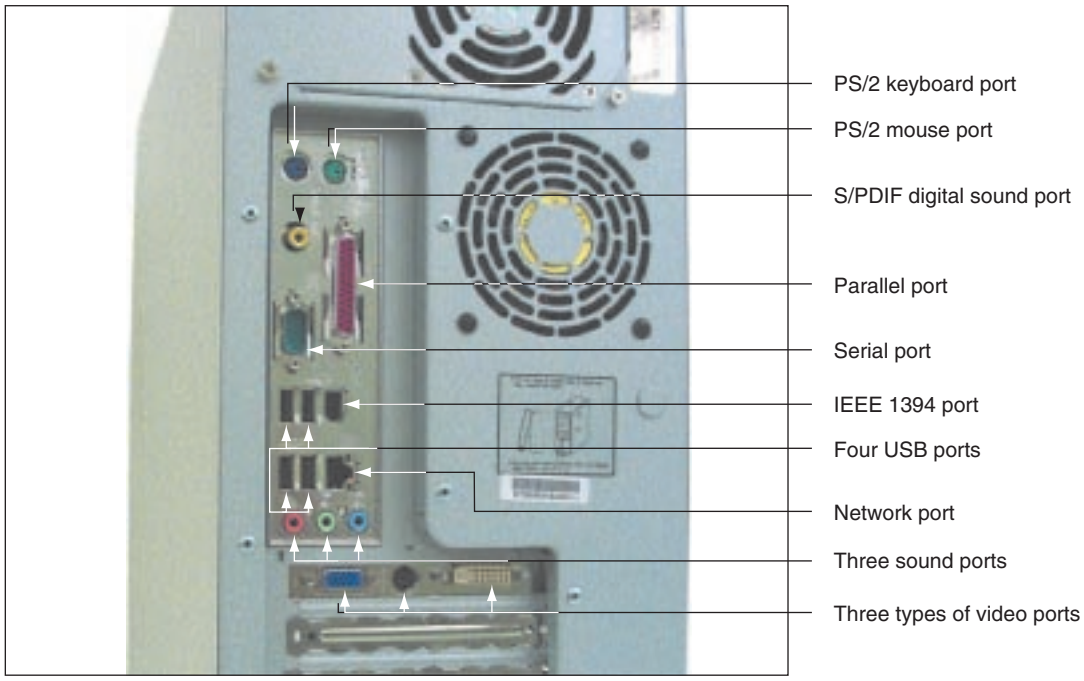

Figure 9-2 Rear of computer case showing ports; only the video ports are not coming directly off the motherboard
Courtesy: Course Technology/Cengage Learning

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know about these motherboard I/O ports: Sound, video, USB 1.1 and 2.0, serial, IEEE 1394 (FireWire), parallel, and PS/2.

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Port Type	Maximum Speed
SuperSpeed USB 3.0	5.0 Gbps (gigabits per second)
eSATA-300 (eSATA Version 2)	3.0 Gbps
1394b (FireWire)*	1.2 Gbps or 800 Mbps (megabits per second)**
Hi-Speed USB 2.0	480 Mbps
1394a (FireWire)	400 Mbps
Original USB (USB 1.1)	12 Mbps or 1.5 Mbps
Parallel	1.5 Mbps
Serial	115.2 Kbps (kilobits per second)

*IEEE 1394b has been designed to run at 3.2 Gbps, but products using this speed are not yet manufactured.
**FireWire 800 is the industry name for 1394b running at 800 Mbps.

Table 9-1 Data transmission speeds for various port types

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USB PORTS

USB ports are fast becoming the most popular ports for slower I/O devices such as printers, mice, keyboards, scanners, joysticks, modems, digital cameras, fax machines, barcode readers, external floppy drives, external hard drives, and digital telephones. USB is much easier to configure and faster than regular serial or parallel ports and uses higher-quality cabling. In addition, power to the device can be drawn from the USB port so that a USB device might not need its own power source. Two or more USB ports are found on all motherboards (see Figure 9-3). Sometimes a case will have one or more USB ports on the front for easy access (see Figure 9-4). And some newer monitors might have a USB port provided by a USB cable plugged into a port on the back of the PC.

USB Version 1.1 (sometimes called Basic Speed USB or Original USB) allows for two speeds, 1.5 Mbps and 12 Mbps, and works well for slow I/O devices. USB Version 2.0 (sometimes called Hi-Speed USB or USB2) allows for up to 480 Mbps, which is 40 times

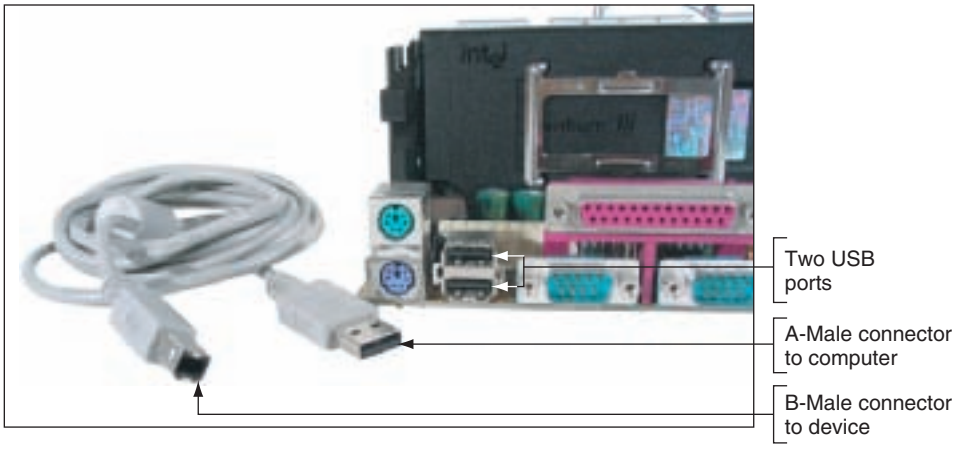

Figure 9-3 A motherboard with two USB ports and a USB cable; note the rectangular shape of the connection as compared to the nearby serial and parallel D-shaped ports
Courtesy: Course Technology/Cengage Learning

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Figure 9-4 One or more USB ports on the front of a computer case make for easy access
Courtesy: Course Technology/Cengage Learning

Caution Even though USB devices are hot-swappable, it's not always a good idea to plug or unplug a device while it is turned on. If you do so, especially when using a low-quality USB cable, you can fry the port or the device if wires in the USB connectors touch (creating a short) as you plug or unplug the connectors. Also, to protect the data on a USB storage device, double-click the **Safely Remove Hardware** icon in the notification area (see Figure 9-5) before removing the device. Select the device and click **Stop** (see Figure 9-6). It is then safe to remove the device.

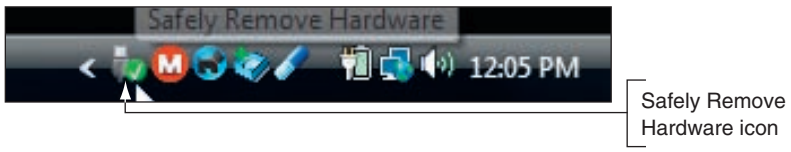

Figure 9-5 Safely Remove Hardware icon in Windows Vista
Courtesy: Course Technology/Cengage Learning

Figure 9-6 Stop the device before removing it
Courtesy: Course Technology/Cengage Learning

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faster than Original USB. Hi-Speed USB is backward compatible with slower USB devices. The latest USB standard is USB 3.0, which is called SuperSpeed USB and runs at 5.0 Gbps. SuperSpeed USB is about 10 times faster than Hi-Speed USB and roughly five times faster than FireWire 800. SuperSpeed USB devices are expected to be on the market sometime in 2010. The USB Implementers Forum, Inc. (*www.usb.org*), the organization responsible for developing USB, has adopted the symbols shown in Figure 9-7 to indicate if the product is certified by the organization as compliant with SuperSpeed, HiSpeed, or Original USB. Windows Vista supports Hi-Speed USB, and Windows XP supports it only if service packs are applied. Windows 7 is expected to support SuperSpeed USB.

Figure 9-7 SuperSpeed, Hi-Speed, and Original USB logos appear on products certified by the USB forum
Courtesy: Course Technology/Cengage Learning

As many as 127 USB devices can be daisy chained together using USB cables. In a daisy chain, one device provides a USB port for the next device. There can also be a stand-alone **hub** into which several devices can be plugged. Figure 9-8 shows an adapter that has two PS/2 connectors so that you can plug a PS/2 keyboard and mouse into the adapter and then use a single USB port for both devices.

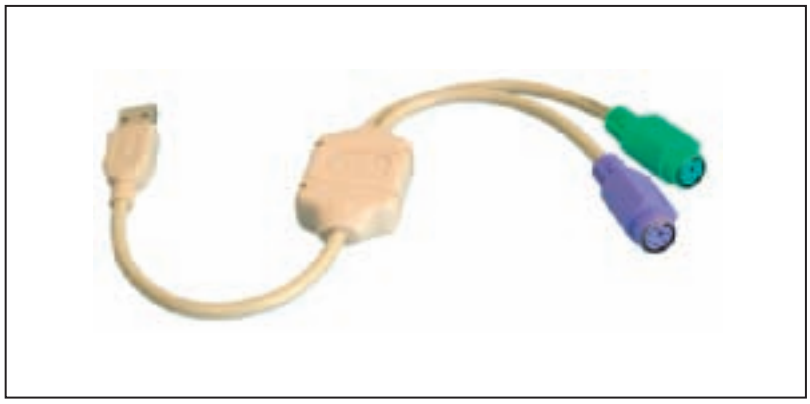

Figure 9-8 PS/2 to USB adapter allows a PS/2 keyboard and mouse to use a single USB port
Courtesy: Course Technology/Cengage Learning

A USB cable has four wires, two for power and two for communication. The two power wires (one is hot and the other is ground) allow the host controller to provide power to a device. The connector on the host computer or hub end is called the A-Male connector, and the connector on the device end of the cable is called the B-Male connector. The A-Male connector is flat and wide, and the B-Male connector is square. (Look back at Figure 9-3 to see both these connectors.) In addition, because some devices such as a digital camera are so small, USB standards allow for mini-A connectors and mini-B connectors. You can see one of these mini-B connectors in Figure 9-9 used with a digital camera. The A-Male connector of this USB cable is regular size to connect to a computer's USB port.

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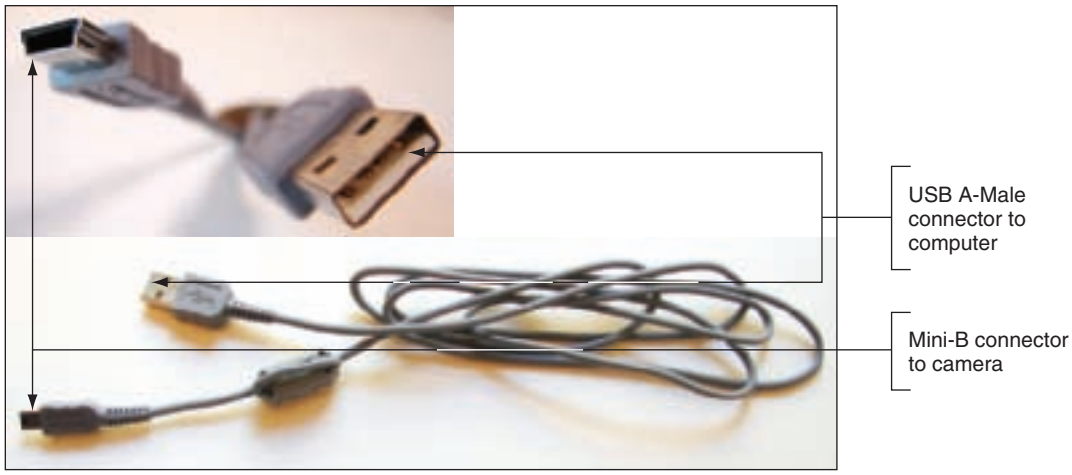

Figure 9-9 The digital camera USB cable uses a mini-B connector and a regular size A-Male connector
Courtesy: Course Technology/Cengage Learning

USB cables for Original USB can be up to 3 meters (9 feet, 10 inches) and Hi-Speed USB cables can be up to 5 meters (16 feet, 5 inches). If you need to put a USB device farther from the PC than the cable is long, you can use a USB hub in the middle to effectively double the distance.

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FIREWIRE (IEEE 1394) PORTS

FireWire and **i.Link** are common names for another peripheral bus officially named **IEEE 1394** (or sometimes simply called 1394). FireWire is similar in design to USB, using serial transmission of data. FireWire devices are hot-pluggable and up to 63 FireWire devices can be daisy chained together.

Notes For interesting information about 1394, surf the 1394 Trade Association's Web site at *www.1394ta.org*.

The two standards for IEEE 1394 that apply to speed are IEEE 1394a and 1394b. 1394a supports speeds up to 400 Mbps and is sometimes called FireWire 400. 1394a allows for cable lengths up to 4.5 meters (15 feet) and for up to 16 cables daisy chained together. 1394a supports two types of connectors and cables: a 4-pin connector that does not provide voltage to a device and a 6-pin connector that does. Figure 9-10 shows a cable that plugs into a 6-pin FireWire port to provide a 4-pin connector for a FireWire device. Figure 9-11 shows an IEEE 1394a controller card that provides two external and one internal FireWire 400 6-pin connectors and one external FireWire 400 4-pin connector.

Tip IEEE 1394a ports with 6 pins are the most common FireWire ports on motherboards.

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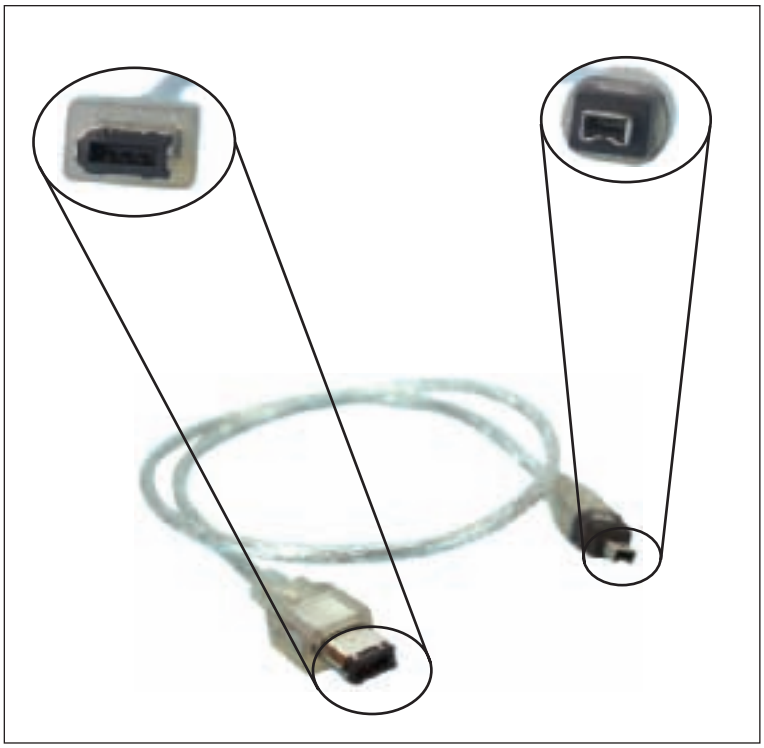

Figure 9-10 IEEE 1394a cable provides a smaller 4-pin and larger 6-pin connectors
Courtesy: Course Technology/Cengage Learning

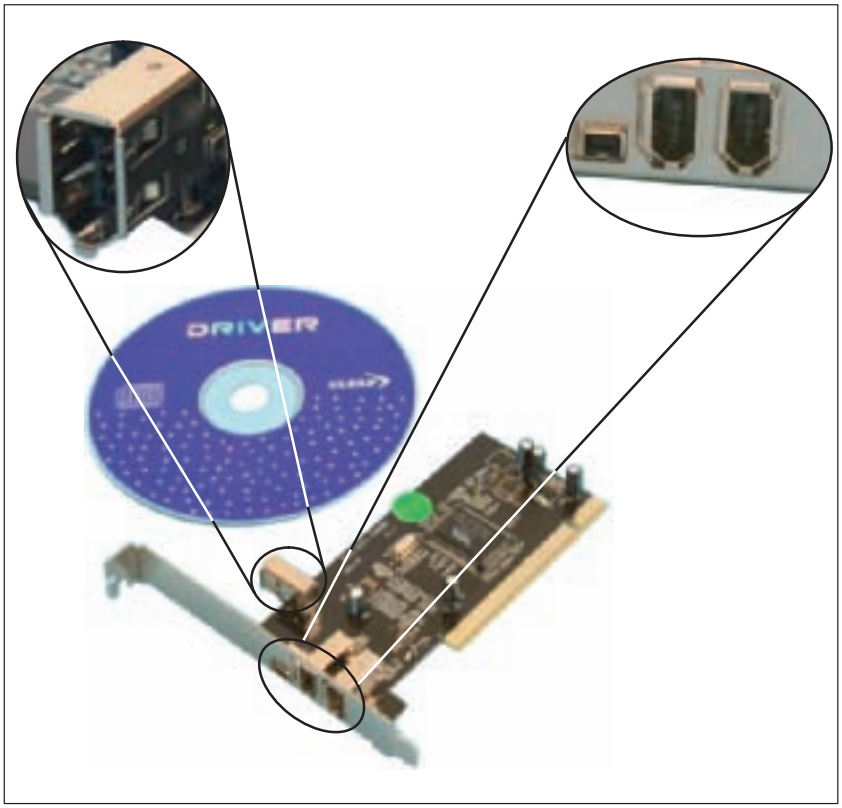

Figure 9-11 IEEE 1394a controller card provides internal and external FireWire 400 ports
Courtesy: Course Technology/Cengage Learning

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The newer standard, 1394b, supports speeds up to 3.2 Gbps, but current devices on the market are running at only 800 Mbps, which is why 1394b is also called FireWire 800. **1394b** can use cables up to 100 meters (328 feet), and uses a 9-pin rectangular connector. You can use a 1394 cable that has a 9-pin connector at one end and 4-pin or 6-pin connector at the other end to connect a slower 1394a device to a faster 1394b computer port. However, know that when you mix standards for speed, the port and the device will run at the slower speed. Figure 9-12 shows a FireWire 800 adapter that provides three 1394 ports: two 1394b 9-pin ports and one 1394a 6-pin port. The power cable connected to the card plugs into a 4-pin power cable from the power supply to provide extra power to the card. The latest 1394 standard is 1394c, which allows FireWire 800 to use a standard network port and network cable. No devices are yet on the market that use this standard.

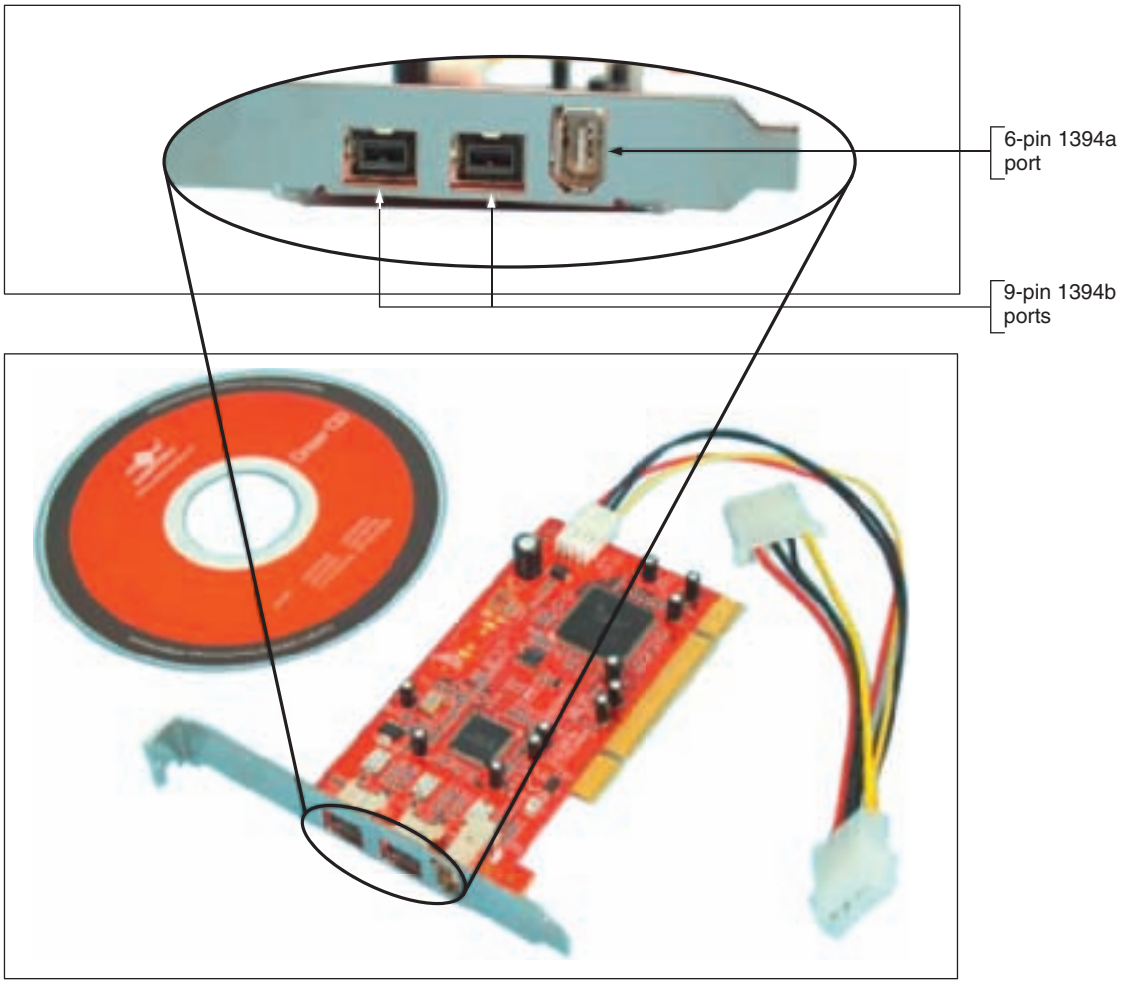

Figure 9-12 This 1394 adapter card supports both 1394a and 1394b and uses a 32-bit PCI slot
Courtesy: Course Technology/Cengage Learning

Notes A variation of 1394 is **IEEE 1394.3**, which is designed for peer-to-peer data transmission. Using this standard, imaging devices such as scanners and digital cameras can send images and photos directly to printers without involving a computer.

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IEEE 1394 uses **isochronous data transfer**, meaning that data is transferred continuously without breaks. This works well when transferring real-time data such as that received by television transmission. Because of the real-time data transfer and the fact that data can be transferred from one device to another without involving the CPU, IEEE 1394 is an ideal medium for data transfers between consumer electronics products, such as camcorders, digital video recorders (for example, TiVo), TVs, and digital cameras.

Figure 9-13 shows an example of how this data transfer might work. A person can record a home movie using a digital camcorder and download the data through a digital video recorder to a 1394-compliant external hard drive. The 1394-compliant digital recorder can connect to and send data to the hard drive without involving the PC. The PC can later read the data off the hard drive and use it as input to video-editing application software. A user can edit the data and design a professional video presentation complete with captioning and special effects. Furthermore, if the digital camcorder is also 1394-compliant, it can download the data directly to the PC by way of a 1394 port on the PC. The PC can then save the data to a regular internal hard drive.

Video
FireWire Ports

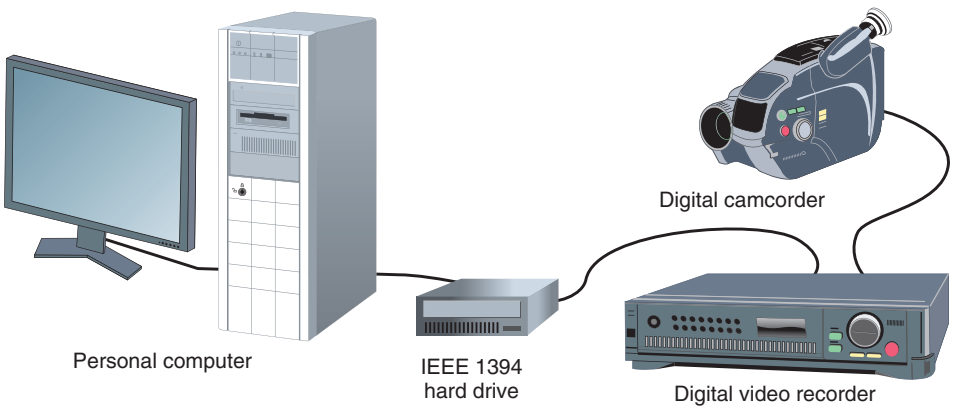

Figure 9-13 IEEE 1394 can be used as the interface technology to connect consumer multimedia equipment to a PC
Courtesy: Course Technology/Cengage Learning

SERIAL PORTS

Serial ports were originally intended for input and output devices such as a mouse or an external modem. Recall from Chapter 1 that a serial port transmits data in single bits, one bit following the next. You can identify these ports on the back of a PC case by (1) counting the pins and (2) determining whether the port is male or female. Serial ports have been mostly outdated by USB ports, and few new computers today have a serial port.

Figure 9-14 shows two serial ports, one parallel port, and one game port for comparison. (A game port is an outdated, legacy port used for joysticks.) Serial ports are sometimes called DB9 and DB25 connectors. DB stands for data bus and refers to the number of pins on the connector. The DB9 port is the most common. Serial ports are almost always male ports, and parallel ports are almost always female ports. A serial port is provided by the motherboard or might be provided by an adapter card called an **I/O controller card**. The controller card is likely to also provide a parallel port or game port. A serial port on the motherboard can be enabled and disabled in BIOS setup.

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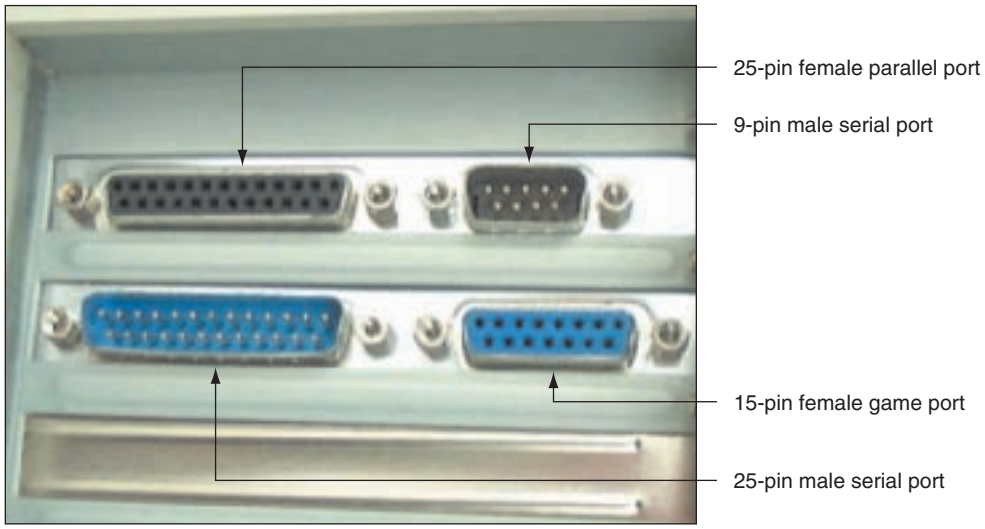

Figure 9-14 Serial, parallel, and game ports
Courtesy: Course Technology/Cengage Learning

Serials ports can go by more than one name. Because a serial port conforms to the interface standard called **RS-232c (Reference Standard 232 revision c or Recommended Standard 232 revision c)**, it is sometimes called an RS-232 port. A serial port might also be called a **COM1 (Communications port 1)** or COM2 port. The controller logic on a motherboard that manages serial ports is called **UART (Universal Asynchronous Receiver-Transmitter)** or UART 16550, which leads us to sometimes call a serial port a UART port. By the way, the UART chip might also control an internal modem that uses resources normally assigned to the serial port.

PARALLEL PORTS

Parallel ports, commonly used by older printers, transmit data in parallel, eight bits at a time. Parallel ports that can handle communication in both directions are called bidirectional parallel ports. Today's printers and OSs expect the printer to be able to communicate with the OS such as when it needs to tell the OS that it is out of paper. These printers require bidirectional parallel ports.

Parallel ports fall into three categories: **Standard Parallel Port (SPP)**, **EPP (Enhanced Parallel Port)**, and **ECP (Extended Capabilities Port)**. The standard parallel port is sometimes called a normal parallel port or a Centronics port, named after the 36-pin Centronics connection used by printers (see Figure 9-15). A standard port allows data to flow in only one direction and is the slowest of the three types of parallel ports. In contrast to a standard port, EPP and ECP are both bidirectional. ECP was designed to increase speed over EPP by using a DMA channel; therefore, when using ECP mode, you are using a DMA channel. Both EPP and ECP are covered under the **IEEE 1284** specifications of the Institute of Electrical and Electronics Engineers (IEEE).

Most parallel cables are only 6 feet (1.8 meters) long, though no established standard sets maximum cable length. However, to ensure data integrity, you should avoid using a parallel cable longer than 15 feet (4.5 meters). (In fact, Hewlett-Packard recommends that cables be no longer than 10 feet, or 3 meters.) If the data is transmitted in parallel over a very long cable, the data integrity is sometimes lost. Although USB ports are replacing parallel ports, most computers still come with one parallel port.

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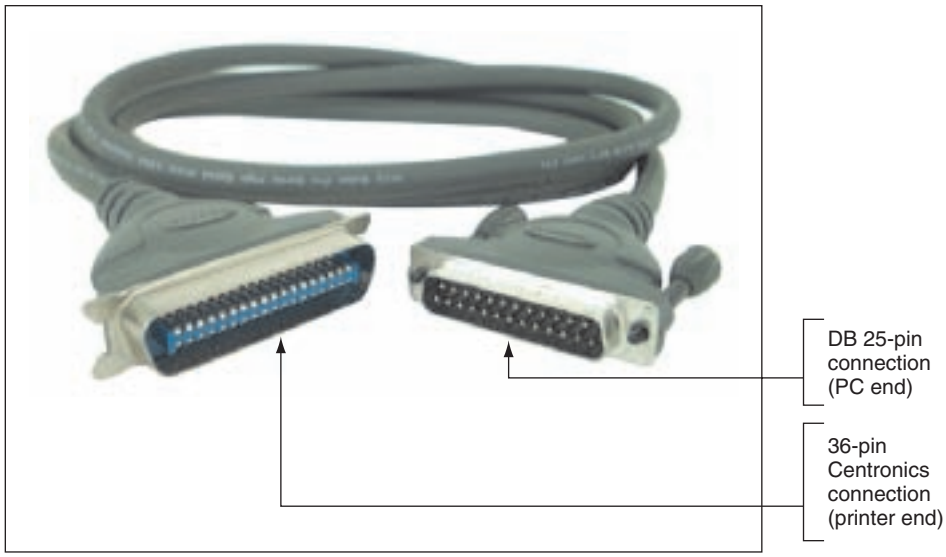

Figure 9-15 A parallel cable has a DB25 connection at the PC end of the cable and a 36-pin Centronics connection at the printer end of the cable
Courtesy of Belkin Corporation

Notes When using EPP or ECP printers and parallel ports, be sure to use a printer cable that is IEEE 1284–compliant. Older, noncompliant cables will not work properly with these printers. To find out if a cable is compliant, look for the label somewhere on the cable. Also, note that a printer using a parallel port can use a 36-pin Centronics connector, or some newer printers use the smaller 36-pin Micro-Centronics or Mini-Centronics connector.

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INFRARED TRANSCEIVERS

An **infrared transceiver**, also called an **IrDA (Infrared Data Association) transceiver** or an **IR transceiver**, provides an infrared port for wireless communication. Television remote controls communicate with the TV or set top box using infrared transmission. On desktop and notebook computers, infrared can be used by wireless keyboards, mice, cell phones, PDAs, and printers. On notebooks, an infrared receiver is often used for communication between the notebook and a PDA (such as a Pocket PC, Blackberry, or smartphone) to transfer information. Also, an older PC might use an infrared device to connect to a network.

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know how an infrared transceiver might be used on a notebook computer.

Figure 9-16 shows a remote control that can be used with multimedia applications installed on a notebook computer. The remote communicates with the notebook by way of an IR transceiver connected to a USB port. To use the remote, the device drivers that came bundled with the device are installed and then the IR transceiver is connected to the USB port.

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Figure 9-16 This remote control is an infrared device that uses an IR transceiver connected to a notebook by way of a USB port
Courtesy: Course Technology/Cengage Learning

Motherboards that support infrared are likely to have two IR header pins, the IR receiver and IR transmitter headers (see Figure 9-17). To use the IR headers, you need to enable infrared in BIOS setup, connect an infrared transceiver to the headers, and install the software in Windows that uses your infrared device. Later, if you have problems with infrared, be sure the infrared drivers that came bundled with the motherboard are installed. Also, try updating these drivers using those you download from the motherboard manufacturer Web site. Older motherboards that support IR transmissions might use the resources normally used by a serial port for IR. For these boards, if you enable infrared in BIOS setup, a serial port might be disabled.

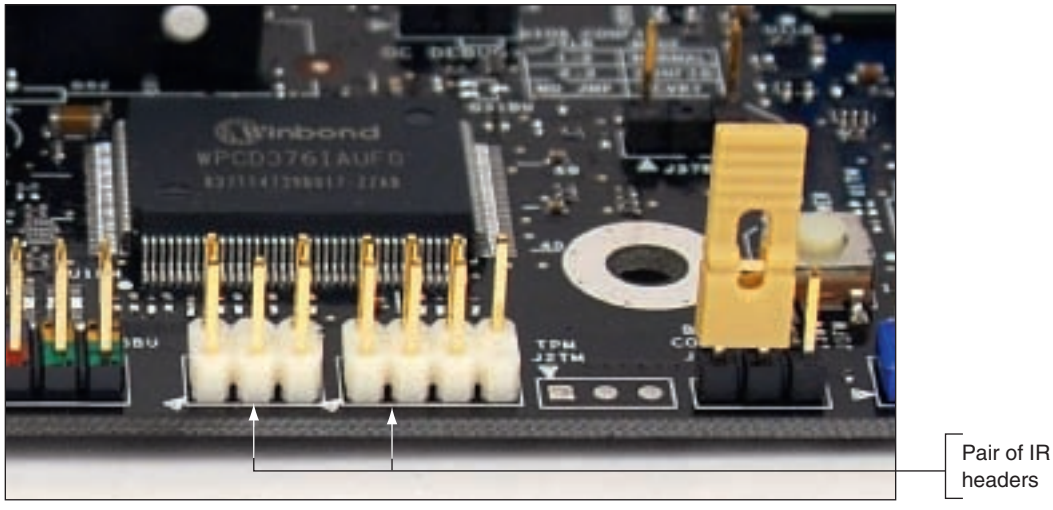

Figure 9-17 Two IR headers on this motherboard are used to install an IR receiver and IR transmitter
Courtesy: Course Technology/Cengage Learning

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Here's a warning and some advice: Finding an infrared transceiver that fits your motherboard IR headers might be difficult and expensive. If you need to use Infrared with a desktop system, the easiest and least expensive solution is to purchase a USB infrared transceiver for a few dollars and use it in a USB port on the board.

Infrared wireless is becoming obsolete because of the line-of-sight issue: There must be an unobstructed "view" between the infrared device and the receiver. Short-range radio technology such as Bluetooth is becoming the most popular way to connect a wireless I/O device to a nearby computer, because with radio waves there is no line-of-sight issue.

Notes Infrared standards are defined by the Infrared Data Association (IrDA). Its Web site is *www.irda.org*.

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DISPLAY DEVICES

The primary output device of a computer is the monitor. The two necessary components for video output are the monitor and the video card (also called the video controller, video adapter, and graphics adapter) or a video port on the motherboard. The two main categories of monitors are the **CRT (cathode-ray tube) monitor** (which takes up a lot of desk space and costs less) and the **LCD (liquid crystal display) monitor** (which frees your desk space, looks cool, and costs more). The older CRT technology was first used in television sets, and the newer LCD technology was first used in notebook PCs. LCD monitors are also called **flat panel monitors** for desktop computers.

Let's now briefly look at how CRT and LCD monitors work, and then we'll look at the different LCD and CRT technologies you need to consider when selecting a monitor. In this part of the chapter, you'll also learn about projectors, which are useful when display is needed for a larger group of people, and then we'll turn our attention to the technologies used with video cards. Later in the chapter, you'll learn how to install and troubleshoot monitors, projectors, and video cards.

HOW A CRT MONITOR WORKS

Many monitors use CRT technology, in which the filaments at the back of the cathode tube shoot a beam of electrons to the screen at the front of the tube, as illustrated in Figure 9-18. Plates on the top, bottom, and sides of the tube control the direction of the beam. The beam is directed by these plates to start at the top of the screen, move from left to right to make

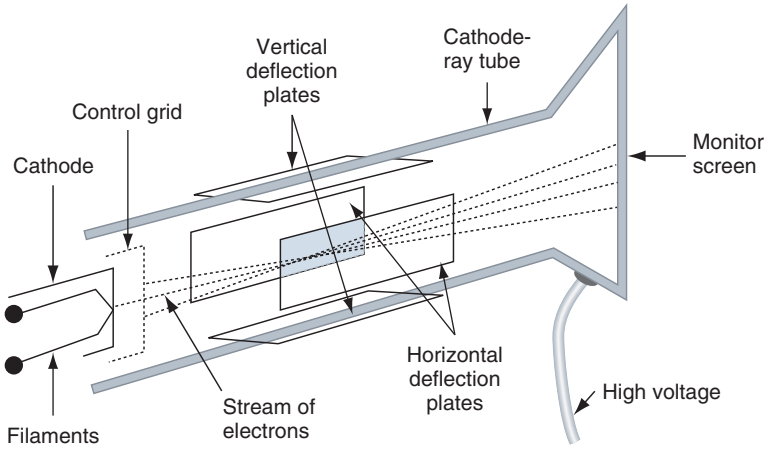

Figure 9-18 How a CRT monitor works
Courtesy: Course Technology/Cengage Learning

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one line, and then move down to the next line, again moving from left to right. As the beam moves vertically down the screen, it builds the image. By turning the beam on and off and selecting the correct color combination, the grid in front of the filaments controls what goes on the screen when the beam hits that portion of the line or a single dot on the screen. When hit, special phosphors on the back of the monitor screen light up and produce colors. The grid controls which one of three electron guns fires, each gun targeting a different color (red, green, or blue) positioned on the back of the screen. The three colors used are called the **RGB (red, green, and blue)** color space. These three dots, one for each color, are called a triad, and the distance between any two dots in the triad is called the dot pitch.

Notes Television and CRT technology were invented by Phil Farnsworth. He got the idea in 1920 of an electron beam drawing a picture by moving across one line and back across the next while plowing a field at the age of 14.

With prices of LCD monitors dropping, CRT monitors are becoming obsolete. One reason to use a CRT monitor is for children. The surface of an LCD monitor can easily be damaged, but CRT monitor surfaces can handle children touching them. Also, some people feel that the display quality of CRT monitors is better than that of LCD monitors.

HOW AN LCD MONITOR WORKS

An LCD monitor produces an image using a liquid crystal material made of large, easily polarized molecules. Figure 9-19 shows the layers of the LCD panel that together create the image. At the center of the layers is the liquid crystal material. Next to it is the layer responsible for providing color to the image. These two layers are sandwiched between two grids of electrodes. One grid of electrodes is aligned in columns, and the other electrodes are aligned in rows. The two layers of electrodes make up the electrode matrix. Each intersection of a row electrode and a column electrode forms one pixel on the LCD panel. Software can manipulate each pixel by activating the electrodes that form it. The image is formed by scanning the column and row electrodes, much as the electronic beam scans a CRT monitor screen.

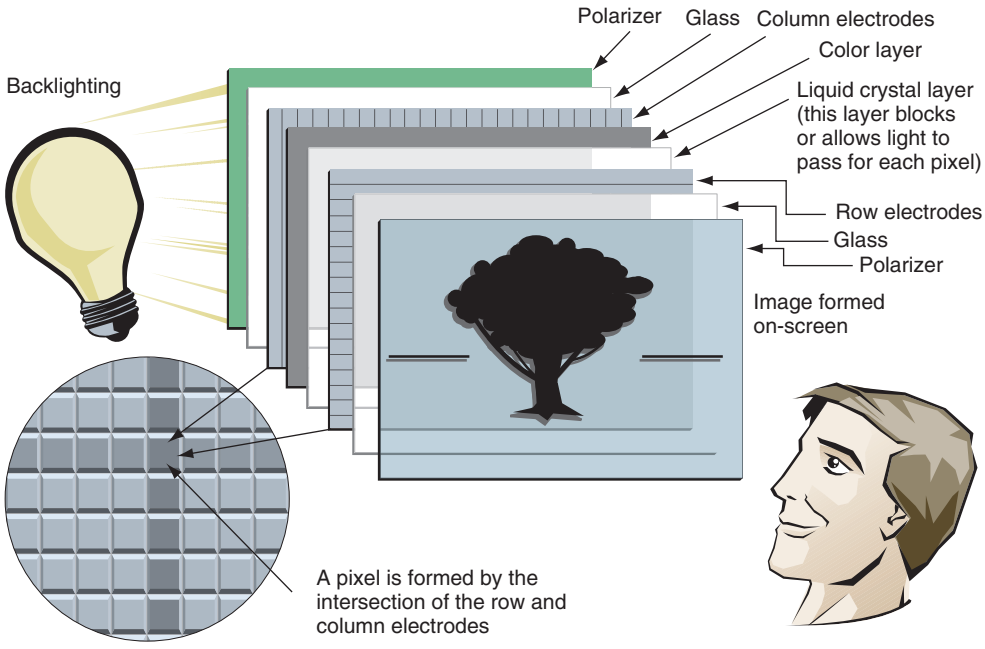

Figure 9-19 Layers of an LCD panel
Courtesy: Course Technology/Cengage Learning

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The polarizer layers outside the glass layers in Figure 9-19 are responsible for preventing light from passing through the pixels when the electrodes are not activated. When the electrodes are activated, light on the backside of the LCD panel can pass through one pixel on the screen, picking up color from the color layer as it passes through the pixel.

Many LCD monitors are built to receive either an analog signal or a digital signal from the video card and have two ports to accommodate either signal. If the signal is analog, it must be converted to digital before the monitor can process it. LCD monitors are designed to receive an analog signal so that a 15-pin analog video port on a computer can be used. Figure 9-20 shows the back of an LCD monitor.

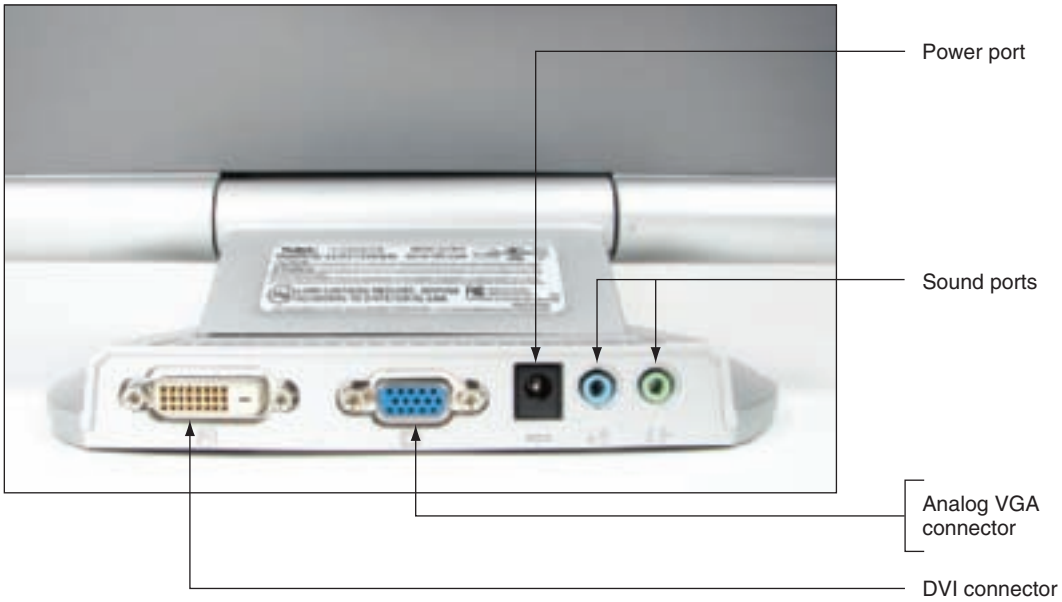

Figure 9-20 The rear of this LCD monitor shows digital and analog video ports to accommodate a video cable with either a 15-pin analog VGA connector or a digital DVI connector
Courtesy: Course Technology/Cengage Learning

LCD AND CRT TECHNOLOGIES

Table 9-2 summarizes the features and technologies that apply to LCD and CRT monitors. Several of the more important ones are discussed in the following subsections.

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know about these monitor settings: Refresh rate, resolution, degauss, and multiple monitors.

Refresh Rate and Response Time

The **refresh rate** is the number of times one screen or frame is built in one second. For CRT monitors, the Video Electronics Standards Association (VESA) set a minimum refresh rate standard of 70 Hz, or 70 complete vertical refreshes per second, as one requirement of **Super VGA (SVGA)** monitors. Many older **VGA (Video Graphics Adapter)** monitors are still in use, but all sold today meet the standards for SVGA. Slower refresh rates make the image appear to flicker, whereas faster refresh rates make the image appear solid and stable. For LCD monitors, the response time, also called the refresh rate, is the time it takes for an LCD monitor to build all the pixels for one screen or frame, and is measured in ms (milliseconds) or Hz. An LCD monitor with a response time of 16 ms yields about the same results as a CRT refresh rate of 60 Hz. LCD response times overall have been slightly less than CRT refresh rates.

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Monitor Characteristic	CRT Monitor	LCD Monitor	Description
Screen size	X	X	Diagonal length of the screen surface. Values can range from 14 to 30 inches. (If you use an LCD television as a monitor, the size can go much higher.)
Refresh rate	X	X	The number of times a screen is built in one second. Common refresh rates are 60, 70, and 75 Hz. A monitor rated at 75 Hz can build 75 frames per second. (For comparison, a movie displays 24 frames per second.)
Interlaced	X		The electronic beam draws every other line with each pass, which lessens the overall effect of a lower refresh rate.
Response time		X	The time it takes for an LCD monitor to build one screen. The lower the better. A monitor with a 12-ms response time can build 83 frames per second, and a 16-ms monitor can build 63 frames per second.
Pixel pitch	X	X	A pixel is a spot or dot on the screen that can be addressed by software. The pixel pitch is the distance between adjacent pixels on the screen. An example of a pixel pitch is .283 mm. The smaller the number, the better.
Resolution	X	X	The number of spots or pixels on a screen that can be addressed by software. Values can range from 640 x 480 up to 1920 x 1200 for high-end monitors.
Native resolution		X	The number of pixels built into the LCD monitor.
Color quality	X	X	The number of bits used to store data about color for each pixel. Values are 8 bits, 16 bits, 24 bits, and 32 bits. Windows calls 24-bit and 32-bit color Truecolor.
Multiscan	X		CRT monitors that offer a variety of refresh rates so they can support several video cards.
Connectors	X	X	Options for connectors are VGA, DVI-I, DVI-D, and HDMI. These and other connectors used by video cards are discussed later in the chapter.
Contrast ratio	X	X	The contrast between true black and true white on the screen. The higher the contrast the better. 1000:1 is better than 700:1.
Viewing angle		X	The angle of view when an LCD monitor becomes difficult to see. A viewing angle of 170 degrees is better than 140 degrees.
Display type for CRT monitors	X		Flat screen monitors are high-end monitors that use a flat screen to help prevent glare.
Display type for LCD monitors		X	TFT (active matrix) is better than DSTN (passive matrix). TFT uses a transistor at each pixel to enhance the pixel.
Backlighting or brightness		X	For LCD monitors, some use better backlighting than others, which yields a brighter and clearer display. Brightness is measured in cd/m^2 (candela per square meter).
Other features		X	LCD monitors can also provide microphone input, speakers, USB ports, adjustable stands, and perhaps even a port for your iPod. Some monitors are also touch screen, so they can be used with a stylus as an input device.

Table 9-2 Important Features of a Monitor

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Caution If you spend many hours in front of a computer, you may strain your eyes. To protect your eyes from strain, look away from the monitor into the distance every few minutes. Use a good monitor with a high refresh rate or response time. The lower rates that cause monitor flicker can tire and damage your eyes. Because the refresh rates of CRT monitors are generally higher than the response times of LCD monitors, people who spend hours and hours in front of a monitor often prefer a CRT monitor. Also, when you first install a monitor, set the rate at the highest value the monitor can support.

Interlaced or Noninterlaced

Interlaced CRT monitors draw a screen by making two passes. On the first pass, the electronic beam strikes only the even lines, and on the second pass, the beam strikes only the odd lines. The result is that a monitor can have a slow refresh rate with a less noticeable overall effect than there would be if the beam hit all lines for each pass. A **noninterlaced** monitor (also called a progressive monitor) draws the entire screen in one pass. Interlaced monitors generally have slightly less flicker than noninterlaced monitors. Buy an interlaced monitor if you plan to spend long hours staring at the monitor. Your eyes will benefit.

Resolution

For CRT monitors, **resolution** is a measure of how many pixels on a CRT screen are addressable by software. Because resolution depends on software, the video controller card must support the resolution, and the software you are using must make use of the monitor's resolution capabilities. The minimum resolution for most monitors is 800 × 600 pixels, although many monitors offer a much-higher resolution.

Whereas a CRT monitor is designed to use several resolutions, an LCD monitor uses only one resolution, called the **native resolution**, which is the actual (and fixed) number of pixels built into the monitor. When you change display settings to use a different resolution than the monitor's native resolution, the LCD displayed area is reduced in size (creating a black area around the display) or video driver software builds each screen by mapping data using the chosen resolution onto the native resolution. This scaling process can slow down response time and/or cause an LCD monitor to appear fuzzy, which is why most serious gamers prefer CRT monitors to LCD monitors. For the sharpest images when using an LCD monitor, use the native resolution. If you do decide to use a different resolution than the native resolution, for the sharpest display, select a resolution that uses the same ratio of horizontal pixels to vertical pixels that the native resolution uses.

Most often, the native resolution is the highest resolution the monitor supports, but this is not always the case. To know for certain what is the native resolution, see the documentation that came with the monitor. Sometimes the monitor displays the native resolution on-screen when you attempt to set the resolution higher than the native resolution. The message displayed by the monitor recommends you use the native resolution.

The different resolution standards are as follows:

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know about these resolutions used on LCD monitors: XGA, SXGA+, UXGA, and WUXGA. In addition, you need to be familiar with these terms: contrast ratio and native resolution.

- VGA (Video Graphics Array) supports up to 640 x 480, which is a 4:3 ratio between horizontal pixels and vertical pixels.
- SVGA (Super VGA) supports up to 800 x 600.
- XGA (eXtended Graphics Array) supports up to 1024 x 768.

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- SXGA (Super XGA) supports up to 1280 x 1024 and was first to use a 5:4 ratio between horizontal pixels and vertical pixels.
- SXGA+ is a variation of SXGA and uses a resolution of 1400 x 1050.
- WSXGA+ (Wide SXGA+) uses a resolution of 1680 x 1050.
- UXGA (Ultra XGA) supports up to 1600 x 1200.
- WUXGA (Wide UXGA) supports up to 1920 x 1200.
- QWXGA (Quad Wide XGA) supports up to 2048 x 1152 and is used by 23" monitors.
- WQXGA (Wide Quad XGA) supports up to 2560 x 1600 and is used by 30" monitors.

To convert the resolution to the number of pixels, multiply the horizontal pixels by vertical pixels. For example, SXGA supports up to 1280 x 1024 pixels or 1.3 million pixels.

CHANGING MONITOR SETTINGS

Settings that apply to the monitor can be managed by using the monitor buttons and Windows utilities. Using the monitor buttons, you can adjust the horizontal and vertical position of the screen on the monitor surface and change the brightness and contrast settings. For laptops, the brightness and contrast settings can be changed using function keys on the laptop. Also, some CRT monitors have a **degauss** button. Press the **degauss button** to eliminate accumulated or stray magnetic fields around the monitor, which can cause a CRT monitor to flicker or have wavy lines.

Monitor and video card settings can be changed by using Windows tools or by using the manufacturer's video card utility that was installed at the time the manufacturer's video card drivers were installed. If this utility is installed, you can access it by right-clicking the desktop and selecting the utility from the shortcut menu. For example, in Figure 9-21, the utility is named NVIDIA Control Panel. Manufacturer drivers for a video card are optional because Windows has its own embedded video drivers. However, for best performance of the card, always install the manufacturer drivers. You will learn how to do this later in the chapter.

To use Windows Vista to adjust resolution and refresh rate, follow these steps:

1. Right-click the Windows desktop and select **Personalize** from the shortcut menu (see Figure 9-21). The Personalization window opens. Click **Display Settings**. (Alternately, you can open the Control Panel and click **Adjust screen resolution**.) The Display Settings dialog box opens (see Figure 9-22).

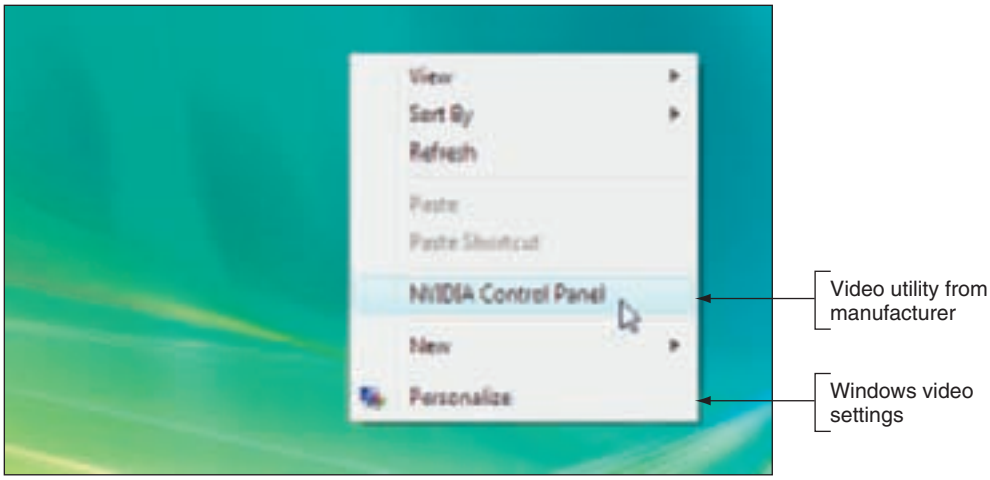

Figure 9-21 Two options are available on this system to adjust display settings
Courtesy: Course Technology/Cengage Learning

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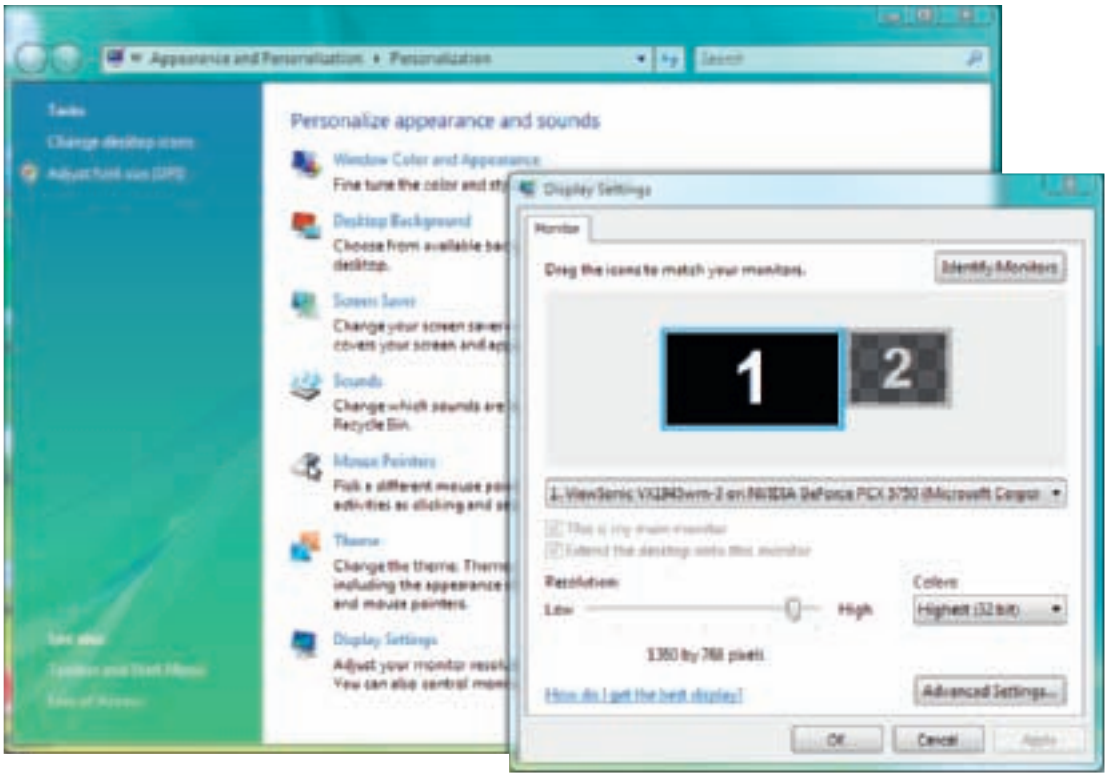

Figure 9-22 Use the Display Settings box to adjust screen resolution
Courtesy: Course Technology/Cengage Learning

2. Use the sliding bar to adjust the resolution. Then click **Apply**. The screen changes and the message "Do you want to keep these display settings?" appears. Click **Yes**.
3. To change the refresh rate, click **Advanced Settings**. The monitor property box opens. Click the **Monitor** tab. Select the largest refresh rate (see Figure 9-23) and click **Apply**. Respond **Yes** to the message, "Do you want to keep these display settings?" Click **OK** to close the properties box.
4. Click **OK** to close the Display Settings box.

Windows supports a standard group of resolutions and normally only lists the ones that a monitor can use. However, sometimes it does not list the monitor's native resolution, or the native resolution is not a standard resolution that Windows offers. If the native resolution is not listed in the Display Settings window, you can do the following:

- In the Display Settings window, click **Advanced Settings** (see Figure 9-24). The adapter and monitor properties box appears. Click **List All Modes**. In the List All Modes box, shown on the right of Figure 9-24, select the resolution you need and click **OK**. Click **Apply**.
- If the native resolution is not listed in the List All Modes box, you can build a customized resolution. The option might be available if a video utility was installed with the video adapter card and the utility includes this option. Right-click the desktop and look for the utility in the shortcut menu (refer back to Figure 9-21). Open the utility and look on the utility window for the option to create a

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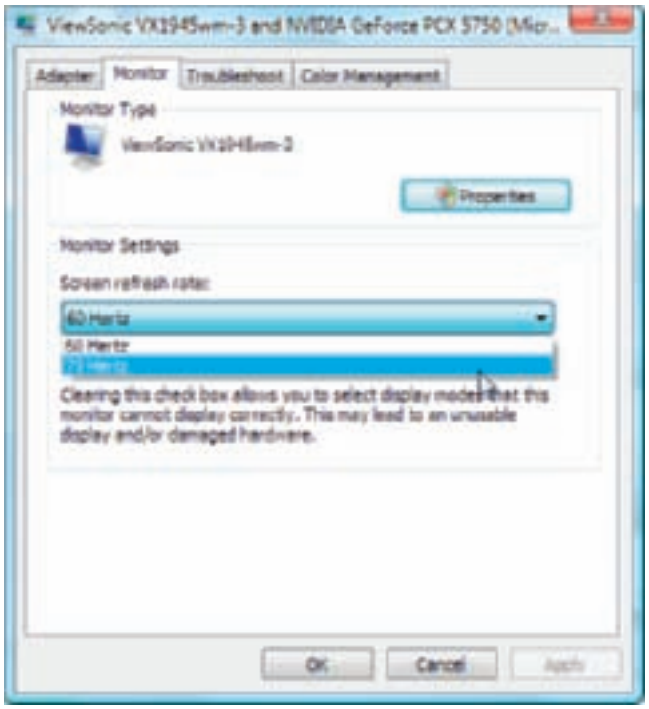

Figure 9-23 Change the refresh rate to the highest setting
Courtesy: Course Technology/Cengage Learning

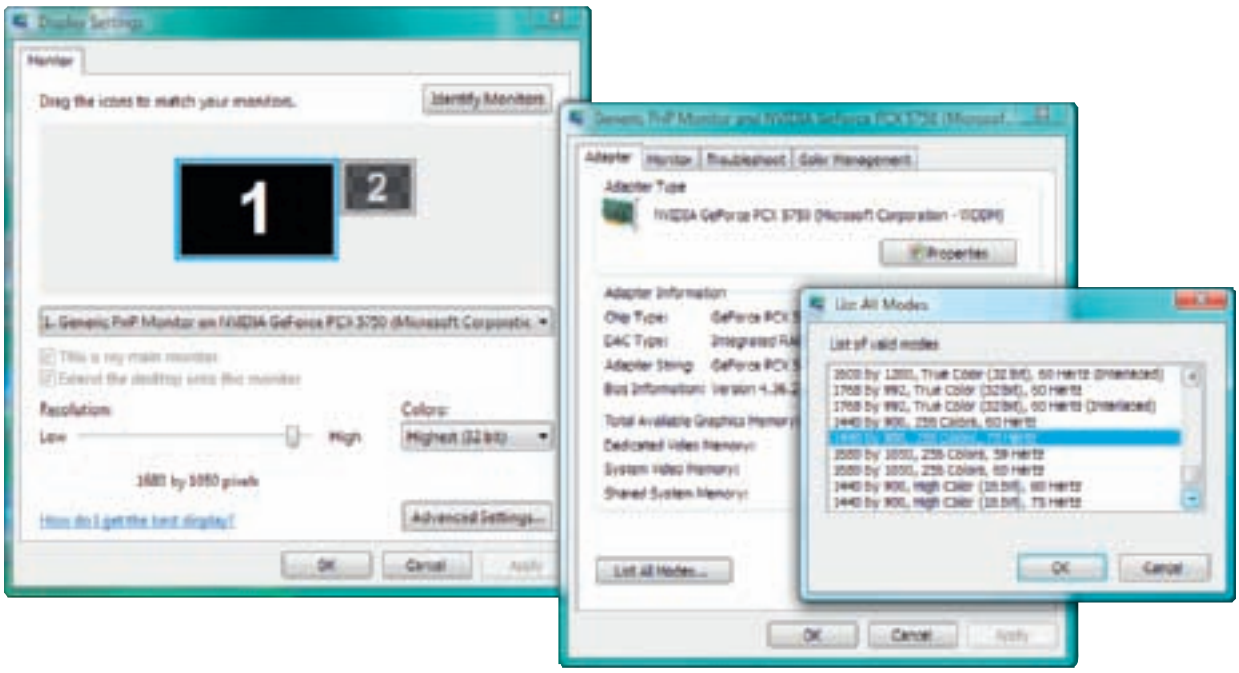

Figure 9-24 Add a new resolution to available resolutions
Courtesy: Course Technology/Cengage Learning

customized resolution. For example, Figure 9-25 shows one utility. To create a customized resolution, select **Manage custom resolution** in the left pane and click **Create** in the right pane. Then, in the Custom Resolutions dialog box, enter the horizontal pixels and vertical lines and click **Test**.

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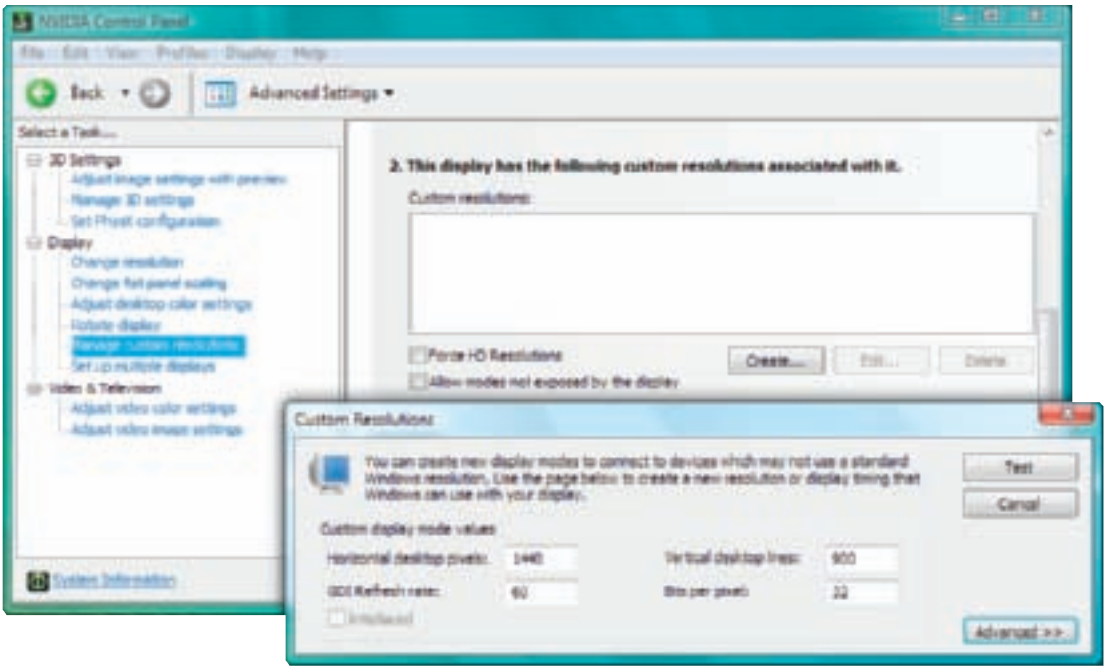

Figure 9-25 Create a customized resolution
Courtesy: Course Technology/Cengage Learning

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APPLYING CONCEPTS

INSTALLING DUAL MONITORS

To increase the size of your Windows desktop, you can install more than one monitor for a single computer. To install dual monitors, you can use two video cards, one for each monitor, or you can use a video card that provides two video ports.

To install a second monitor in a dual-monitor setup using two video cards, follow these steps:

1. Verify that the original video card works properly, determine whether it is PCI Express or AGP, and decide whether it is to be the primary monitor.
2. Boot the PC and enter BIOS setup. If BIOS setup has the option to select the order that video cards are initialized, verify that the currently installed card is configured to initialize first. If it does not initialize first, then, when you install the second card, video might not work at all when you first boot with two cards.
3. Install a second video card in an empty PCI or PCI Express slot, and attach the second monitor.
4. Boot the system. Windows recognizes the new hardware and launches the Found New Hardware wizard. You can use the wizard to install the video card drivers or cancel the wizard and install them manually. To install the drivers manually, insert the CD that came with the card and launch the setup program on the CD.
5. Now you are ready to configure the new monitor. For Vista, right-click the desktop and select **Personalize** from the shortcut menu. Then click **Display Settings**. The Display Settings box appears (see Figure 9-26). For XP, right-click the desktop and select **Properties** from the shortcut menu. The Display Properties dialog box for Windows XP appears. Select the **Settings** tab.

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Figure 9-26 You must choose to activate a second monitor before it will be used by Windows Vista
Courtesy: Course Technology/Cengage Learning

6. Notice that there are two numbered boxes that represent your two monitors. When you click one of these boxes, the drop-down menu changes to show the selected monitor, and the screen resolution and the color quality display settings also follow the selected monitor. This lets you customize the settings for each monitor. If necessary, arrange the boxes so that they represent the physical arrangement of your monitors.
7. Adjust your resolution and the color quality settings according to your preferences. To cause Windows to extend your desktop onto the second monitor, check **Extend the desktop onto this monitor**. To save the settings, click **Apply**. The second monitor should initialize and show the extended desktop.
8. Close the Vista Display Settings or XP Display Properties dialog box. Open an application and verify that you can use the second monitor by dragging the application over to the second monitor's desktop.

After you add a second monitor to your system, you can move from one monitor to another simply by moving your mouse. Switching from one monitor to the other does not require any special keystroke or menu option.

Video
Using Dual Monitors

Notes In Figure 9-26, if you arrange the two windows side by side, your extended desktop will extend left or right. If you arrange the two windows one on top of the other, your extended desktop will extend up and down.

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PROJECTORS

A monitor gives excellent performance when only two or three people are viewing, but you may want to use a projector in addition to a monitor when larger groups of people are watching. Projectors are great in the classroom, for sales presentations, or for watching the Super Bowl with your friends. The prices of projectors have dropped significantly in the past few years, making them more of an option for business and pleasure. One portable projector, shown in Figure 9-27, has a native resolution of XGA 1024 x 768, and can connect to a desktop or notebook computer by way of a 15-pin video port or S-Video port.

Figure 9-27 Portable XGA projector by Panasonic
Courtesy of Panasonic

To use a projector, you'll need an extra video port. For desktop computers, you'll need to install a second video card or use a video card that has two video ports. Most notebook computers are designed to be used with projectors and provide the extra 15-pin video port or S-Video port. To use a projector, plug in the projector to the extra port and then turn it on. For a notebook computer, use a function key to activate the video port. For most notebooks, you can toggle the function key to: (1) use the LCD display and not use the port; (2) use both the LCD display and the port; or (3) use the port and don't use the LCD display. Also, when you first use the projector, it will show a mirrored image of exactly what you see on your LCD panel. If you want to make the projector an extension of the desktop, you can open the Vista Display Setting box or the XP Display Properties box, select the second monitor, and select **Extend the desktop onto this monitor**. The projector now works as a dual monitor.

Notes Many of us use Microsoft PowerPoint for group presentations. If you configure your projector as a dual monitor, you can use PowerPoint to display a presentation to your audience on the projector at the same time you are using your LCD display to manage your computer. To do so for PowerPoint 2007, select the **Slide Show** tab, **Set Up** group. Then click **Set Up Slide Show**. In the Set Up Show box under Multiple monitors, check **Show Presenter View** and click **OK**.

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VIDEO CARDS

Video cards (see Figure 9-28) are sometimes called graphic adapters, graphics cards, or display cards. Sometimes the video controller with a video port is integrated into the motherboard. If you are buying a motherboard with an integrated video controller, make sure that you can disable the controller on the motherboard if it gives you trouble. You can then install a video card and bypass the controller and port on the motherboard. Recall from

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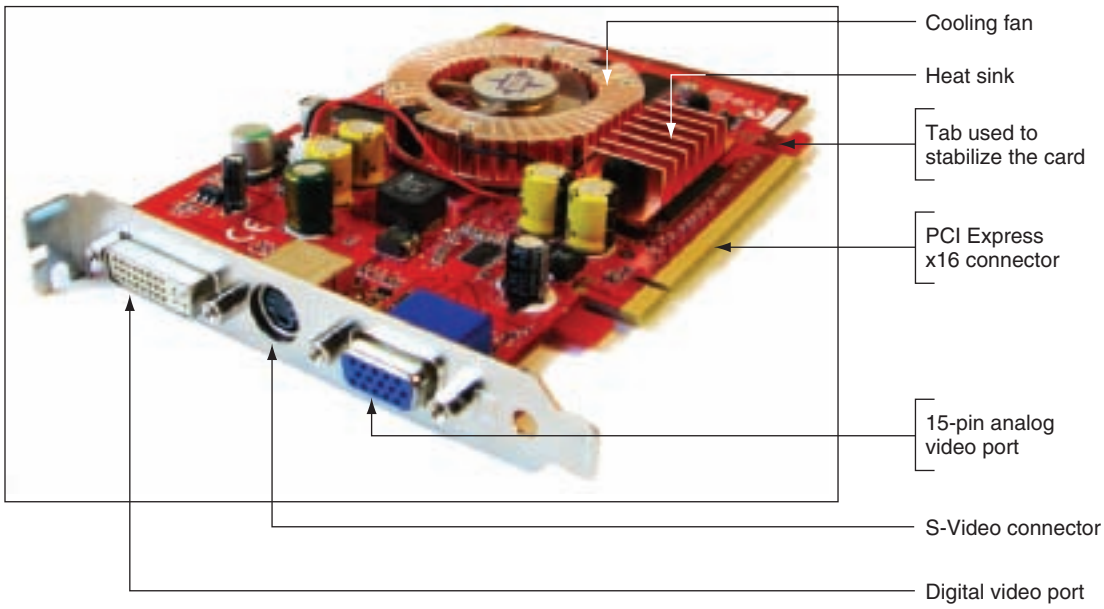

Figure 9-28 The PCX 5750 graphics card by MSI Computer Corporation uses the PCI Express x16 local bus
Courtesy of MSI Computer Corporation

Chapter 5 that a video card can use an AGP, PCI, or PCI Express slot on the motherboard. The fastest slot to use is a PCIe x16 slot.

Now let's look at the ports provided by video cards and other features to consider when selecting a video card.

Ports Provided by Video Cards

Video cards and display devices might use one or more of the following video ports:

- *15-pin VGA port*. This is the standard analog video method of passing three separate signals for red, green, and blue (RGB), which older video cards and CRT monitors use. The video card in Figure 9-29 has this 15-pin VGA port.

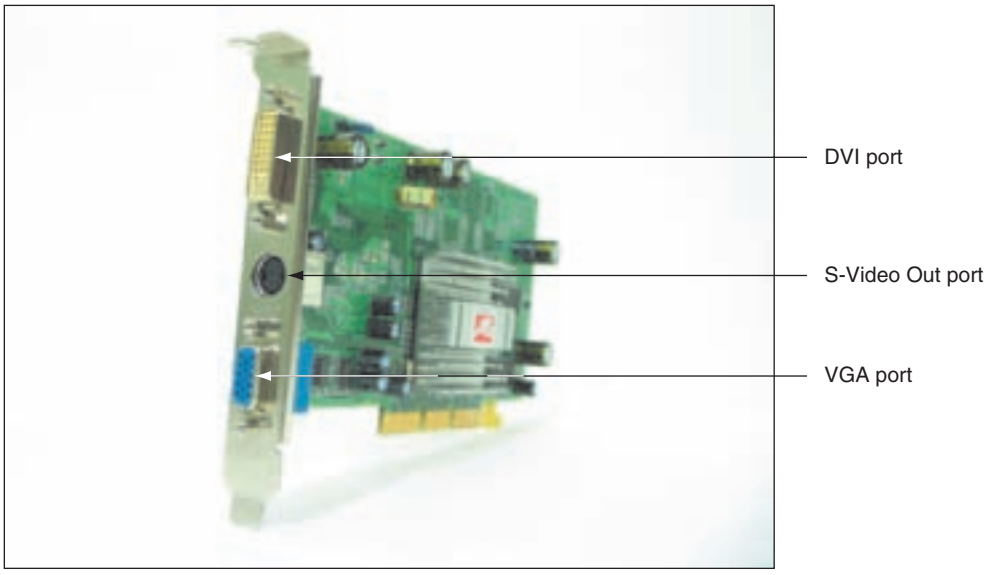

Figure 9-29 This ATI Radeon video card has three ports for video out: DVI, S-Video, and the regular VGA port
Courtesy of ATI Technologies, Inc.

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- *DVI (Digital Visual Interface)*. This method is the digital interface standard used by digital monitors such as a digital LCD monitor and digital TVs (HDTV). For a video card that only has a DVI port, you can purchase a VGA converter so you can connect a standard VGA video cable to use a regular analog monitor (see Figure 9-30). There are two types of DVI ports, which are shown in Figure 9-31. The **DVI-I** port supports both analog and digital signals and the **DVI-D** port works only with digital monitors. If a video card has a DVI port, most likely it will be the DVI-I port (the one with the four extra holes) so that you can use an adapter to convert the port to a VGA port.

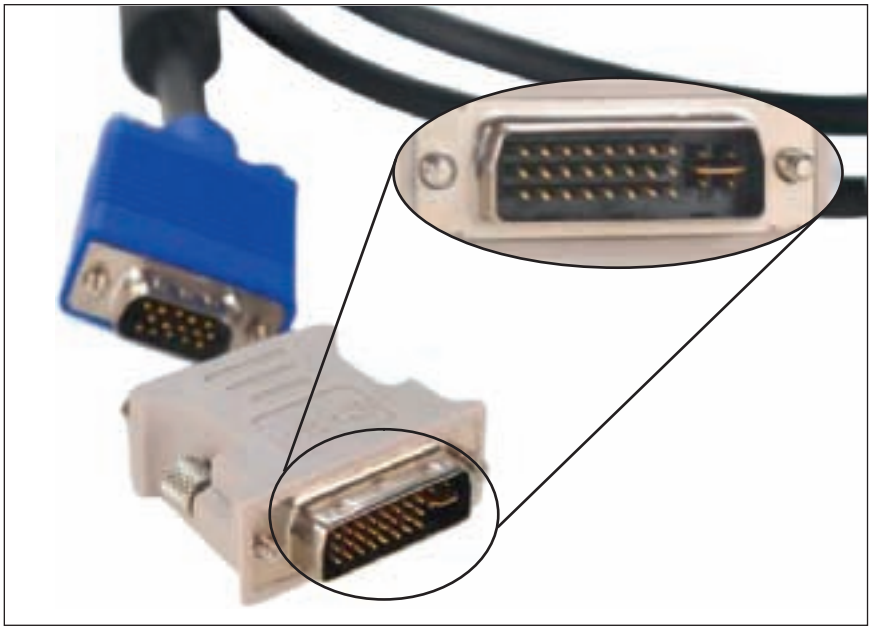
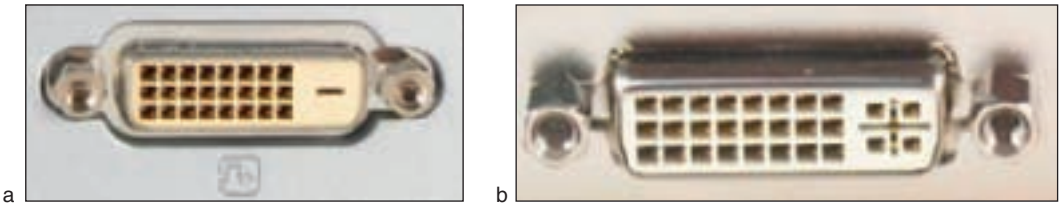


Figure 9-30 Digital to analog video port converter using DVD-I connector with extra four pins
Courtesy: Course Technology/Cengage Learning



a b

Figure 9-31 Two types of DVI ports: (a) DVI-D, (b) DVI-I
Courtesy: Course Technology/Cengage Learning

- *Composite out port*. Using this port, the red, green, and blue (RGB) are mixed together in the same signal. This is the method used by television, and can be used by a video card that is designed to send output to a TV. A composite out port is round and is the same size as the S-Video Out port shown in Figure 9-29, but has only a single pin in the center of the port. Composite video does not produce as sharp an image as RGB video or S-Video.

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- *S-Video (Super-Video) port*. An **S-Video port** sends two signals over the cable, one for color and the other for brightness, and is used by some high-end TVs and video equipment. It uses a 4-pin round port. The television and the video card must support this method and you must use an S-Video cable like the one shown in Figure 9-32. This standard is not as good as RGB for monitors, but is better than composite video when output to a television.

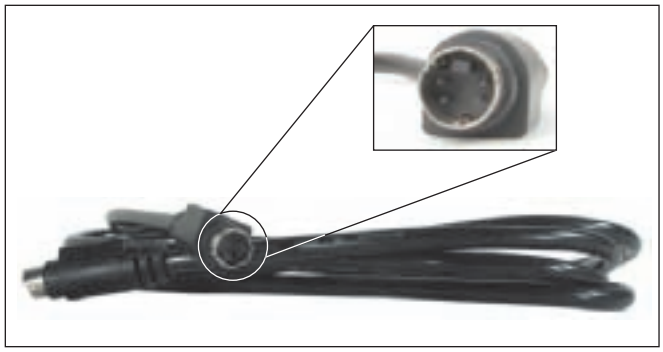

Figure 9-32 An S-Video cable used to connect a video card to an S-Video port on a television
Courtesy: Course Technology/Cengage Learning

- *HDMI port*. **HDMI (High-Definition Multimedia Interface)** is the latest digital audio and video interface standard. It is not widely available on video cards or motherboards, but is expected to ultimately replace DVI. HDMI is currently used on televisions and other home theater equipment. To connect a PC to this equipment that uses HDMI, you can purchase an HDMI to DVI cable such as the one shown in Figure 9-33.

Figure 9-33 An HDMI to DVI cable can be used to connect a PC that has a DVI port to home theater equipment that uses an HDMI port
Courtesy of Belkin Corporation

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know about these video connector types: VGA, HDMI, S-Video, composite (RGB), DVI-D, and DVI-I connectors.

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Other Video Card Features

Video cards offer many different features that affect price and performance. Video cards have their own processor called a graphics processor unit (GPU) or video processor unit (VPU). These processors use graphics RAM installed on the card so that RAM on the motherboard is not tied up with video data. (If a motherboard offers a video port rather than using a video card, the GPU is part of the onboard video controller and RAM on the motherboard is used for video data.)

The more RAM installed on the card, the better the performance. Older video cards used older video memory technologies, including VRAM (video RAM), SGRAM (synchronous graphics RAM), WRAM (window RAM), MultiBank DRAM (MDRAM), 3-D RAM, Direct RDRAM (DRDRAM), and DDR. Most video cards used and sold today use DDR2, DDR3, Graphics DDR3 (GDDR3), or GDDR4 memory. Graphics DDR memory is faster than regular DDR memory and does a better job of storing 3-D images. Some video cards have as much as 2 GB of graphics memory.

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VIDEO MEMORY AND WINDOWS VISTA

Recall from Chapter 2 that most versions of Windows Vista offer the Aero user interface (also called Aero glass), which has a 3D appearance. For these versions of Vista to enable the interface, the onboard video or video card must support DirectX 9 or higher, have at least 128 MB of video memory, and use the Windows Display Driver Model (WDDM). The Windows Display Driver Model is a Windows component new to Windows Vista that manages graphics. DirectX is a Microsoft software development tool that software developers can use to write multimedia applications such as games, video-editing software, and computer-aided design software. Components of DirectX include DirectDraw, DirectMusic, DirectPlay, and Direct3D. The video firmware on the video card or motherboard chipset can interpret DirectX commands to build 3D images as presented to them by the WDDM. In addition, Vista relies on DirectX and the WDDM to produce the Aero user interface.

You can use the **dxdiag.exe** command to display information about hardware and diagnose problems with DirectX. To use the command in Vista, click **Start**, type **dxdiag.exe** in the Start Search box, and press **Enter**. The opening window appears in Figure 9-34. Click the **Display** tab to see information about the installed video card (see Figure 9-35).

The 128 MB or more of video memory can be the graphics memory embedded on the video card, system memory, or a combination of both. To see the video memory available to Vista, open the **Display Settings** dialog box and click **Advanced Settings**. The video properties box appears. Figure 9-36 shows two properties boxes for two systems. The box on the left is for a notebook computer and the one on the right is for a desktop computer that has a video card.

Here is an explanation of the four entries in the dialog box that concern video memory:

- Total Available Graphics Memory is total memory that may be available to the video subsystem.
- Dedicated Video Memory that is found on a video card. Since the notebook has no video card, the value is zero. The video card in the desktop system has 128 MB of graphics memory. Memory on the video card is dedicated to video because no other component has access to it.
- System Video Memory is system RAM dedicated to video. No other application or component can use it.
- Shared System Memory is system RAM that might be available to video if another application or component is not already using it.

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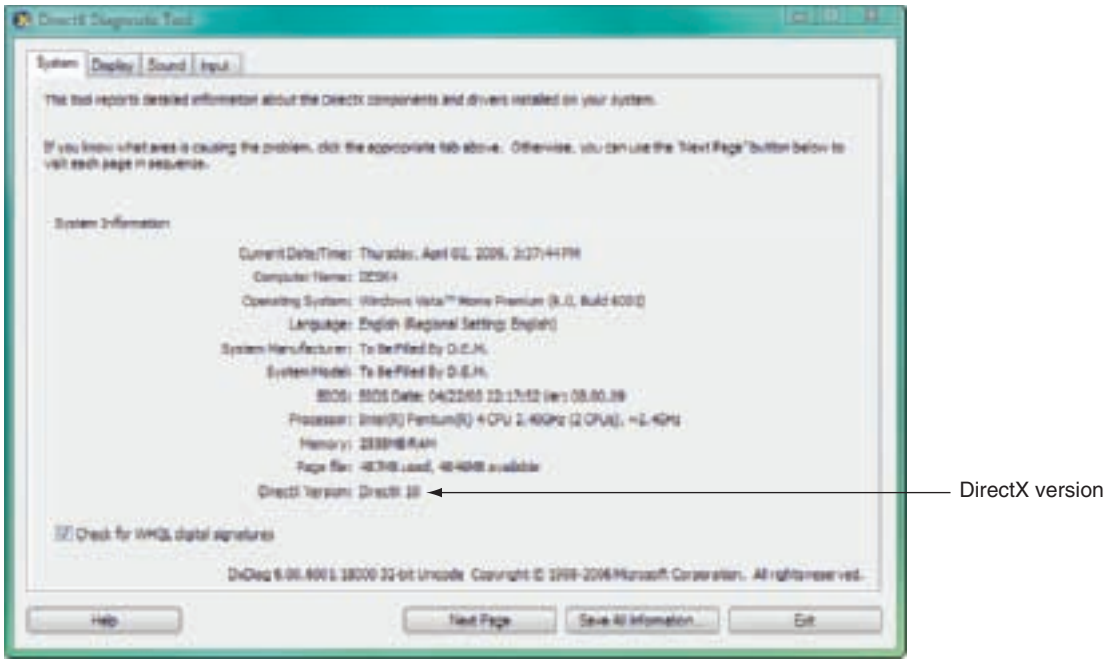

Figure 9-34 The DirectX Diagnostic tool reports information about DirectX components
Courtesy: Course Technology/Cengage Learning

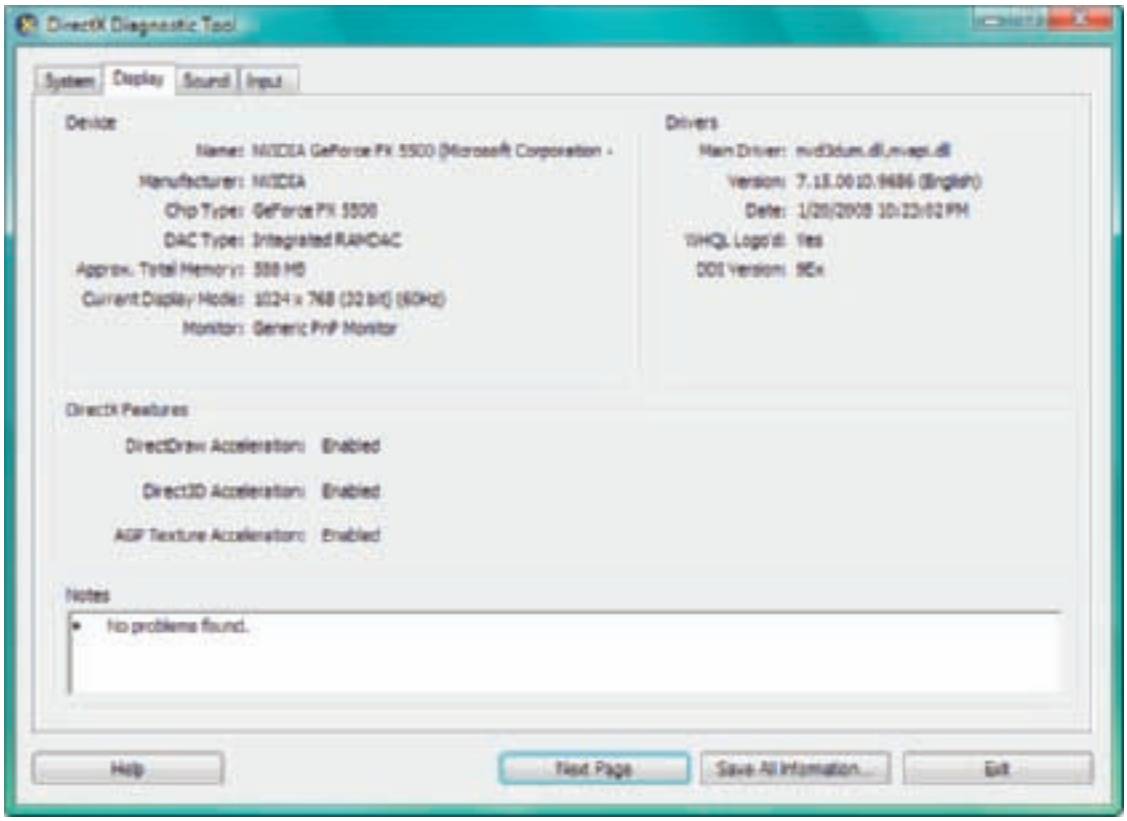

Figure 9-35 DirectX Diagnostic tool reports information about the installed video card and drivers
Courtesy: Course Technology/Cengage Learning

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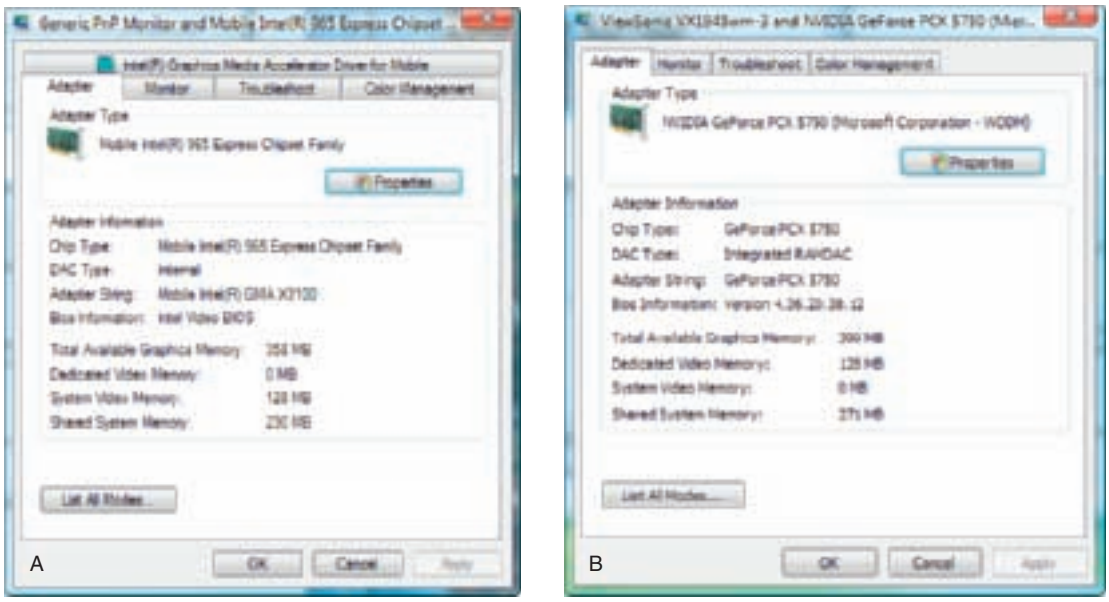

Figure 9-36 Memory allocated to video under Windows Vista (a) for a notebook computer and (b) for a desktop computer with video card
Courtesy: Course Technology/Cengage Learning

For Vista to enable the Aero user interface, at least 128 MB must be dedicated to video. In other words, Dedicated Video Memory and System Video Memory must add up to at least 128 MB. Because this is true for both the notebook and desktop computers, they both use the Aero user interface.

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DUAL VIDEO CARDS

Recall from Chapter 5 that the serious game enthusiast who has a motherboard with two PCI Express x16 slots can use two video cards designed to work in tandem using one of two technologies: SLI by NVIDIA and CrossFire by ATI Technologies. Figure 9-37 shows a video card that supports SLI. Notice in the figure the connector on the card that can be used to connect this card to the second video card using an SLI bridge shown in Figure 9-38. You'll see an example of how to install dual SLI video cards later in the chapter.

Notes Even though high-end graphics cards can have heat sinks and fans, they can still overheat. One possible solution is a slot fan such as the one shown in Figure 9-39 that mounts in any empty slot. Put it next to the video card to help keep it cool.

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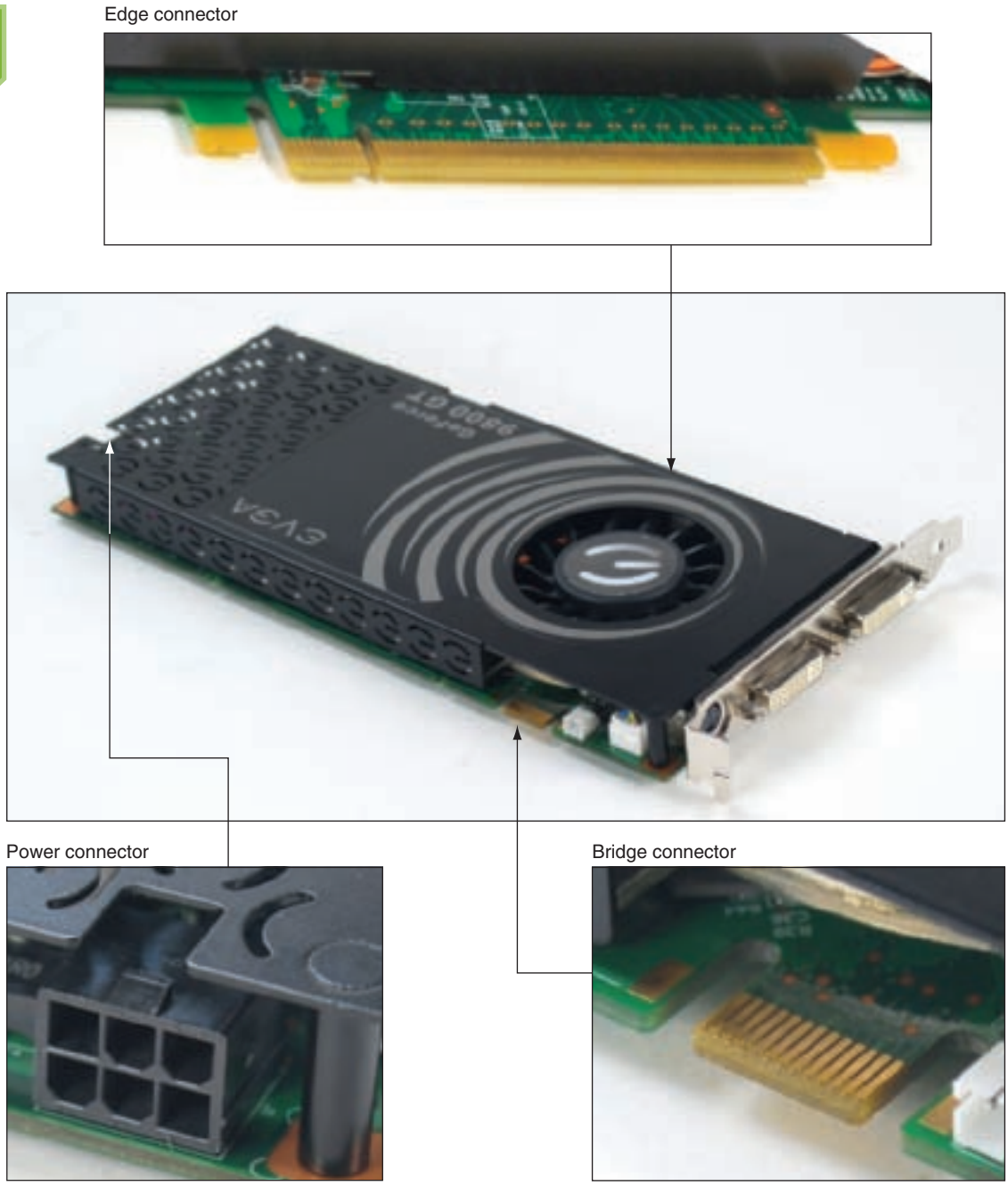

Figure 9-37 This video card is SLI compliant and can be installed with a second matching video card in a system
Courtesy: Course Technology/Cengage Learning

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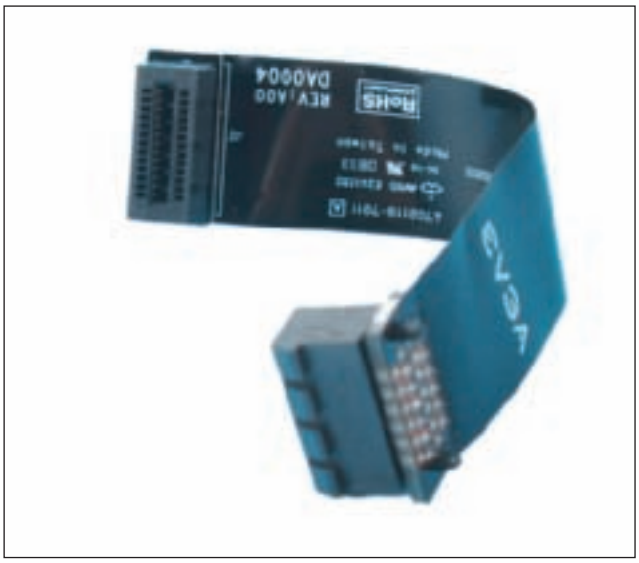

Figure 9-38 SLI bridge connects two SLI video cards
Courtesy: Course Technology/Cengage Learning

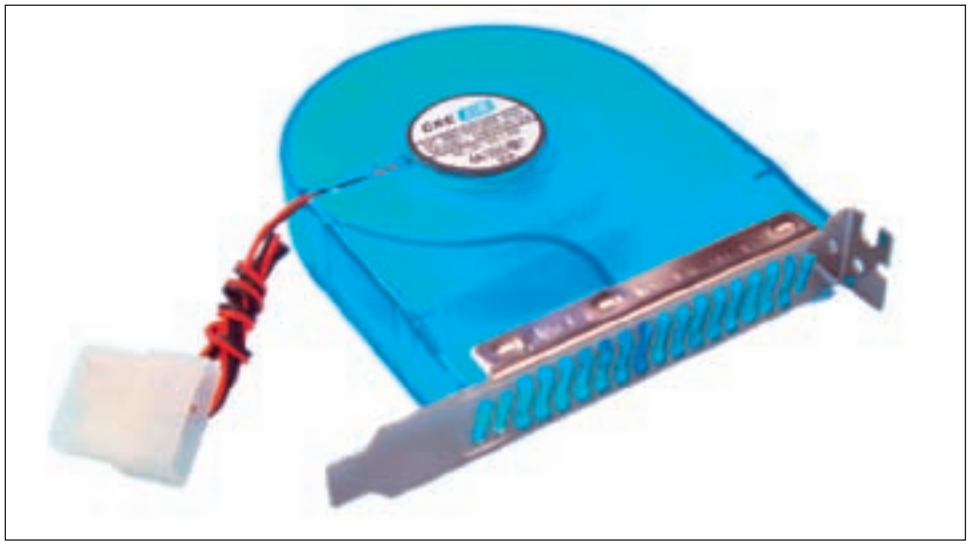

Figure 9-39 Mount this slot fan by Cables Unlimited next to the video card to help keep it cool
Courtesy: Course Technology/Cengage Learning

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EXPANSION CARDS

Listed below, in no particular order, are some common types of expansion cards, many of which you have already learned about in this and other chapters:

1. An I/O controller card can provide serial, parallel, USB, or game ports.
2. A storage controller card can provide SATA and PATA internal ports and eSATA external ports. In addition, the card might support RAID. You learned about SATA, PATA, eSATA, and RAID in Chapter 8.
3. A SCSI host controller card (also called a SCSI adapter) can provide internal and external SCSI ports. SCSI is covered in Chapter 8.
4. A FireWire controller card can provide one or more types of FireWire ports.
5. A sound card provides various sound ports used for input and output. Sound cards are covered in Chapter 10.
6. A video card can use a PCI, PCIe, or AGP slot.
7. A fan card installs in a slot and provides one or two fans used to cool cards in adjacent slots.
8. Network cards can provide network ports for a wired network or an antenna for a wireless network. You'll learn to use these cards in Chapter 18.
9. A modem card can be used to connect your computer to a phone line. You can then use that phone line to connect to the Internet. Modem connections to the Internet are covered in Chapters 17 and 18.
10. A TV tuner card can turn your computer into a television by providing a jack for you to plug up your TV cable. A capture card not only receives TV input but can capture that input into video and audio files. These cards are covered in more detail in Chapter 10.

When selecting an expansion card, consider all the features of the card, the bus slot the card uses, the operating system the card is compatible with, the hardware resources it requires (processor, RAM, and free hard drive space), and the application software that works with the card. You will learn how to install an expansion card later in the chapter.

INSTALLING INPUT DEVICES

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Installing input devices is easy to do and usually goes without a hitch. All devices need device drivers or BIOS to control them and to interface with the operating system. Simple input devices, such as the mouse and keyboard, can be controlled by the BIOS or have embedded device drivers built into the OS. For these devices, you don't have to install additional device drivers.

In this part of the chapter, you'll learn how to install a keyboard, mouse, touch screen, barcode reader, and fingerprint reader. These installations are similar, so learning to do one will help you do the next. And finally, you'll learn how to install a **KVM (Keyboard, Video, and Mouse) switch** that can be used to connect a single keyboard, mouse, and monitor to multiple computers.

HOW TO INSTALL A KEYBOARD AND MOUSE

Most often, installing a keyboard and mouse simply means plugging them in and turning on the PC. Keyboards and mice connect to a PC by one of four methods: a 5-pin round DIN connector (mostly outdated now), a 6-pin PS/2 connector (sometimes called a mini-DIN), a USB port, or

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a wireless connection. DIN and PS/2 connectors are shown in Figure 9-40. Adapters can be used to connect a PS/2 device into a USB connector or a USB device into a PS/2 connector.

Figure 9-40 Two PS/2 and DIN connectors used by keyboards and mice
Courtesy: Course Technology/Cengage Learning

Notes Most computer cases have two PS/2 connectors: one for the mouse and the other for the keyboard. Physically, the mouse or keyboard connector fits into either port, but the mouse connector only works in the mouse port, and the keyboard connector only works in the keyboard port. This can make for a frustrating experience when setting up a computer. To help tell the two ports apart, know that a green PS/2 port is probably the mouse port and a purple port is most likely the keyboard port. Older motherboards did not color-code the mouse and keyboard ports, but you might find small icons imprinted beside the ports to help you distinguish one from the other.

A keyboard or mouse might use a wireless connection, such as the mouse shown in Figure 9-41. The wireless connection is made through a receiver that plugs into a USB port. To install the device, plug the receiver into a USB port and then use the mouse.

Figure 9-41 Wireless mouse and USB receiver
Courtesy: Course Technology/Cengage Learning

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Sometimes you'll need to install drivers with a keyboard and mouse that have special features. For example, the keyboard shown in Figure 9-42 has a zoom bar and buttons and the mouse has extra buttons. If you don't want to use these special features, you can plug the keyboard or mouse into a USB port and use it with no further installation. However, to use the special features, you have to first install the drivers on the CD that came bundled with the two devices.

Figure 9-42 The mouse and keyboard require drivers to use the extra buttons and zoom bar
Courtesy: Course Technology/Cengage Learning

Do the following to install this keyboard and mouse:

1. Insert the CD in the CD drive and run the Setup.exe program on the CD. In Vista, respond to the UAC box.
2. On the installation screen, accept the end-user license agreement (EULA) and select the keyboard and mouse from a list the CD supports. The drivers then install.
3. After the drivers are installed, you must restart the computer. Then plug in the keyboard and mouse to USB ports.
4. Use the two utilities installed on the Windows desktop to configure the mouse and keyboard buttons (see Figure 9-43).

Most devices that have been installed in a system appear listed in Device Manager. And you can use Device Manager to uninstall, disable, or enable the device. However, USB devices are managed differently. To uninstall a USB device, in the Vista Control Panel, click **Uninstall a program** (see Figure 9-44). In the Programs and Features window (see Figure 9-45), select the device and click **Change**. Follow directions on-screen to uninstall the device.

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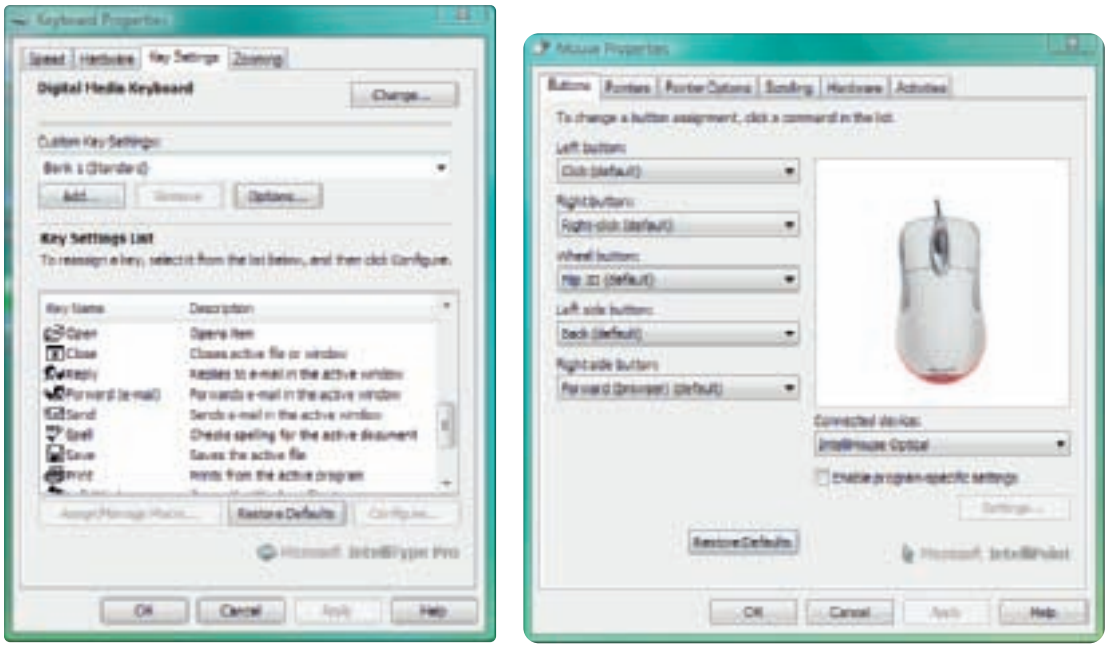

Figure 9-43 Utilities to configure the keyboard and mouse
Courtesy: Course Technology/Cengage Learning

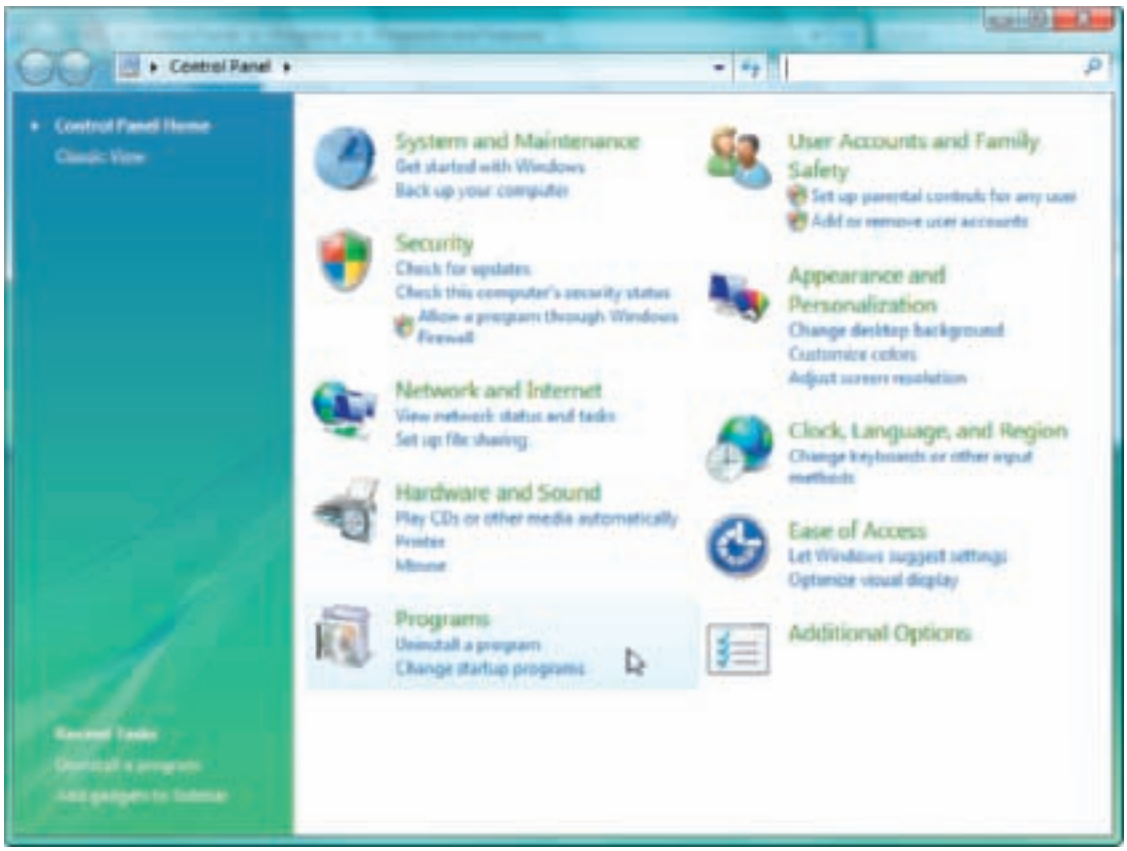

Figure 9-44 Use Control Panel to uninstall a USB device
Courtesy: Course Technology/Cengage Learning

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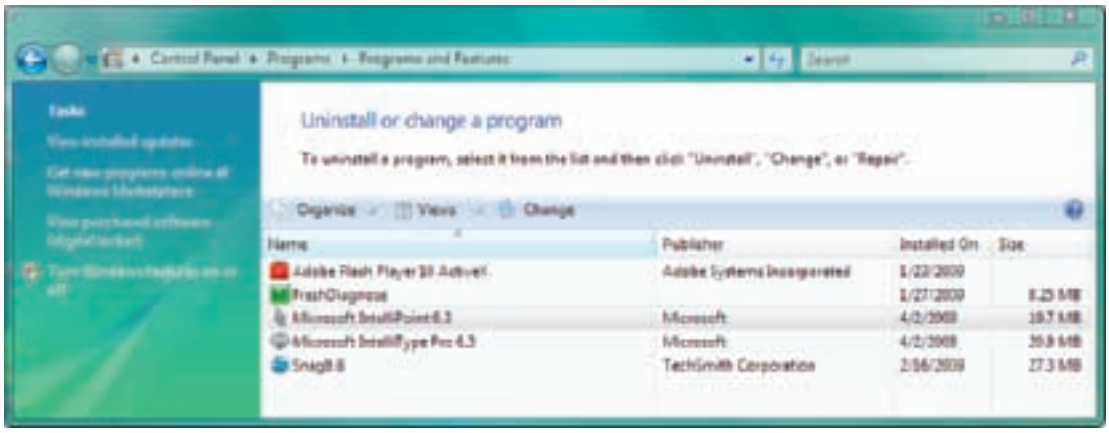

Figure 9-45 USB devices are listed as installed programs
Courtesy: Course Technology/Cengage Learning

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HOW TO INSTALL A TOUCH SCREEN

A **touch screen** is an input device that uses a monitor or LCD panel as the backdrop for input options. In other words, the touch screen is a grid that senses clicks and drags (similar to those created by a mouse) and sends these events to the computer by way of a USB or serial connection.

When someone is using a touch screen, the monitor displays user options and the user touches one of these options. The touch screen receives that touch in a way similar to how a mouse would receive a click. A touch screen can be embedded inside a monitor for a desktop system or an LCD panel in a notebook, or the touch screen can be installed on top of the monitor screen or LCD panel as an add-on device. As an add-on device, the touch screen has its own AC adapter to power it.

When installing a touch screen, follow the manufacturer's directions to connect the USB or serial cable and the power cable and install the touch screen device drivers and management software. Here are general directions to install a touch screen:

1. Run the setup.exe program on the CD that came bundled with the touch screen. The program will install the device drivers for the touch screen and software to manage the device. Restart your computer.
2. Run the management software to select how much of the monitor screen will be devoted to the touch screen or which monitor in a dual-monitor setup will use the touch screen.
3. Connect the USB or serial cable to the touch screen and the computer. The Windows Found New Hardware message appears. Follow directions on-screen to complete the Found New Hardware wizard.
4. Use the management software to calibrate the touch screen to account for the monitor's resolution.

Later, if the monitor resolution is changed, the touch screen must be recalibrated. The screen can be cleaned with a damp cloth using a mild solution of alcohol and water.

HOW TO INSTALL A BARCODE READER

A barcode reader is used to scan barcodes on products to maintain inventory or at the point of sale (POS). Barcode readers come in a variety of shapes, sizes, and features, including a pen wand (simplest and least expensive), slot scanners (to scan ID cards as they are slid

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through a slot), a CCD scanner (a charge-coupled device scanner is a gun-type scanner often used at checkout counters), an image scanner (includes a small video camera), and a laser scanner (most expensive and best type).

A barcode reader can interface with a PC using several methods. Some readers use a wireless connection, a serial port, a USB port, or a keyboard port. If the reader uses a keyboard port, most likely it has a splitter (called a keyboard wedge) on it for the keyboard to use, and data read by the barcode reader is input into the system as though it were typed using the keyboard. Figure 9-46 shows a barcode reader by Intermec that is a laser scanner and that uses Bluetooth to connect wirelessly to the PC.

Figure 9-46 Handheld or hands-free barcode scanner by Intermec Technologies
Photograph courtesy of Intermec Technologies

When a barcode reader scans a barcode, it converts the code into numbers that are transferred to software on the computer. This software identifies two types of information from the numeric code: the company and the product. At point of sale, this information is then used to look up the price of the product in price tables accessed by the software.

To install a barcode reader, first install the device drivers and then plug in the device to the keyboard, USB, or serial port. For a Bluetooth connection, follow the barcode reader's documentation to use the Bluetooth management software on the PC to sync the reader to the PC.

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HOW TO INSTALL A FINGERPRINT READER

A **biometric device** is an input device that inputs biological data about a person, which can be input data to identify a person's fingerprints, handprints, face, voice, eye, and handwritten signature. For convenience, some people enjoy using a fingerprint reader to log onto their Windows desktop or a Web site rather than having to enter a password. These fingerprint readers are not to be considered as the only authentication to control access to sensitive data: for that, use a strong password, which you will learn about in Chapter 19.

Fingerprint readers can look like a mouse and use a wireless or USB connection, such as the one shown in Figure 9-47. Or they can be embedded on the side of a keyboard or

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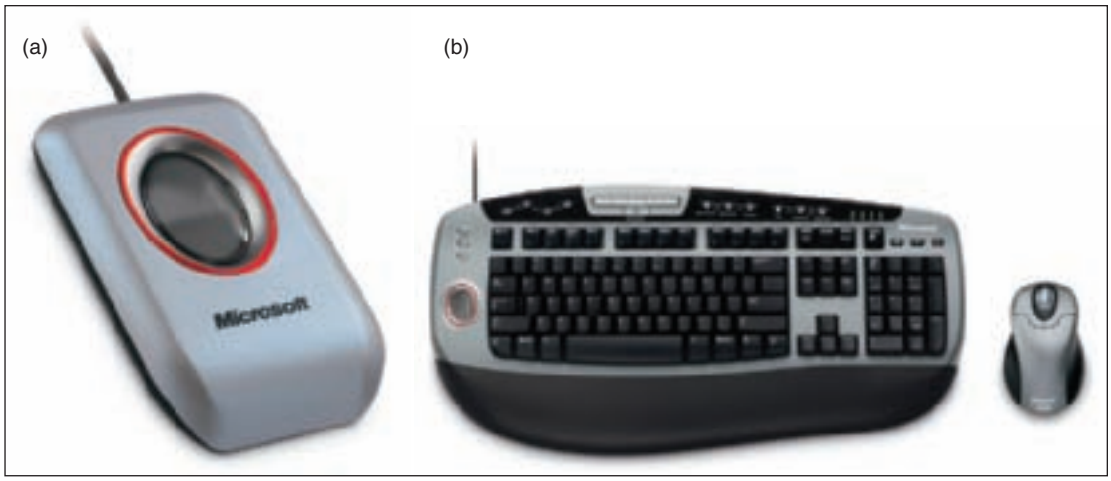

Figure 9-47 Fingerprint readers can (a) look like a mouse, but smaller, or (b) be embedded on a keyboard
Courtesy of Microsoft Corporation

on the side of a flash drive. For notebook computers, a reader might be embedded on the notebook or use a device fitted in a PC Card slot, or the notebook has a fingerprint reader embedded near the keyboard. To use some fingerprint readers, you press your finger on the oval input surface, and for other readers, you slide your finger across a bar that scans your fingerprint as it goes by.

Notes For more information about biometric devices and how they can be used, see the Web site of the International Biometric Industry Association at *www.ibia.org*.

A+ Exam Tip The A+ 220-701 Essentials exam expects you to know how to install and configure these input devices: mouse, keyboard, barcode reader, biometric devices, and touch screens. All these devices are covered in this part of the chapter.

Most fingerprint readers that are not embedded in other devices use a USB connection. For most USB devices, you install the software before you plug in the device. For example, to use the fingerprint reader by Microsoft, which is shown in Figure 9-47, do the following:

1. Insert the setup CD in the optical drive. The installation program on the CD launches. You must accept the license agreement. Figure 9-48 shows one window of the installation process where you are reminded that a fingerprint reader is not to be used when security is required.
2. During the installation process, you are told to plug in the reader so it can be enabled. Do so when you are prompted.
3. Next, the Fingerprint Registration Wizard launches so that you can record your fingerprint (called registering your fingerprint). Figure 9-49 shows one screen in the wizard where you select which finger it is you are about to record.

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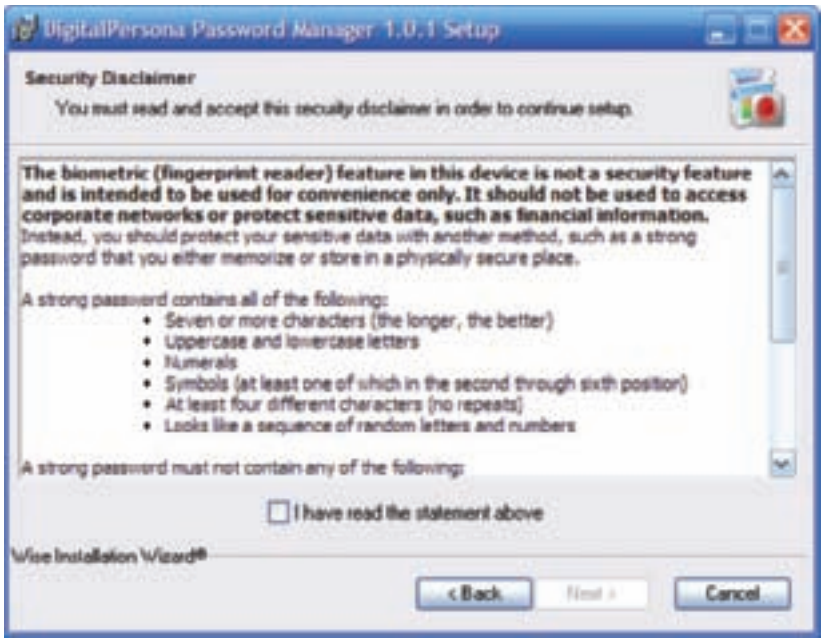

Figure 9-48 The setup program for this fingerprint reader warns to not rely on the reader to protect sensitive data
Courtesy: Course Technology/Cengage Learning

Figure 9-49 To register a fingerprint, select the finger you want to record
Courtesy: Course Technology/Cengage Learning

4. Then on the next screen, which is shown in Figure 9-50, press the reader four times to verify your fingerprint. You can then record more fingerprints or close the wizard.
5. To use your fingerprints in the place of passwords, when you are logging onto Windows or onto a Web site, press your finger to the fingerprint reader.

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Figure 9-50 A fingerprint is registered after it is recorded four times
Courtesy: Course Technology/Cengage Learning

Fingerprint readers that are used a lot can get dirty and refuse to read. To clean a fingerprint reader, use the sticky side of duct tape or clear tape, or clean it with a mild solution of glass cleaner containing ammonia. Don't use an alcohol solution to clean fingerprint readers.

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HOW TO INSTALL A KVM SWITCH

A **KVM (Keyboard, Video, and Mouse) switch** allows you to use one keyboard, mouse, and monitor for multiple computers (see Figure 9-51). A KVM switch can be useful in a dorm room, server room, office, help desk center, or other place where you use more than one computer and want to keep desk space clear of multiple keyboards, mice, and monitors or you simply want to lower the cost of peripherals. Some KVM switches also have sound ports so one set of speakers can be used for multiple computers. Another optional feature is extra USB ports for other USB devices than keyboards and mice, so other USB devices can be shared by multiple computers.

Figure 9-51 This KVM switch supports up to four computers, uses PS/2 ports for the keyboard and mouse, and provides microphone and speaker ports for sound
Courtesy: Course Technology/Cengage Learning

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KVM switches can support 2 to 16 computers or even more and can cost less than $30 to several hundred dollars. Be careful when selecting a KVM switch, so that the switch will support the keyboard, mice, and monitor you want to use. For example, some KVM switches only support ball mice (the type that has a ball that rolls on the bottom of the mouse) and not optical mice (the type that uses a light beam to sense movement). Many KVM switches only support PS/2 mice and keyboards and will not work with the USB variety. Also, less expensive KVM switches do not support keyboard and mice with extra features such as a keyboard zoom bar or Internet Explorer Favorites buttons. The monitor most likely can only use a 15-pin VGA port although a VGA to DVI adapter might work.

The switch does not require that you install device drivers to use it. Just plug in mouse, keyboard, and monitor cables from each computer to the device. Also plug in the one monitor, mouse, and keyboard to the device. Figure 9-52 shows the hardware configuration for the KVM switch in Figure 9-51. Switch between computers by using a hot key on the keyboard or buttons on the top of the KVM switch.

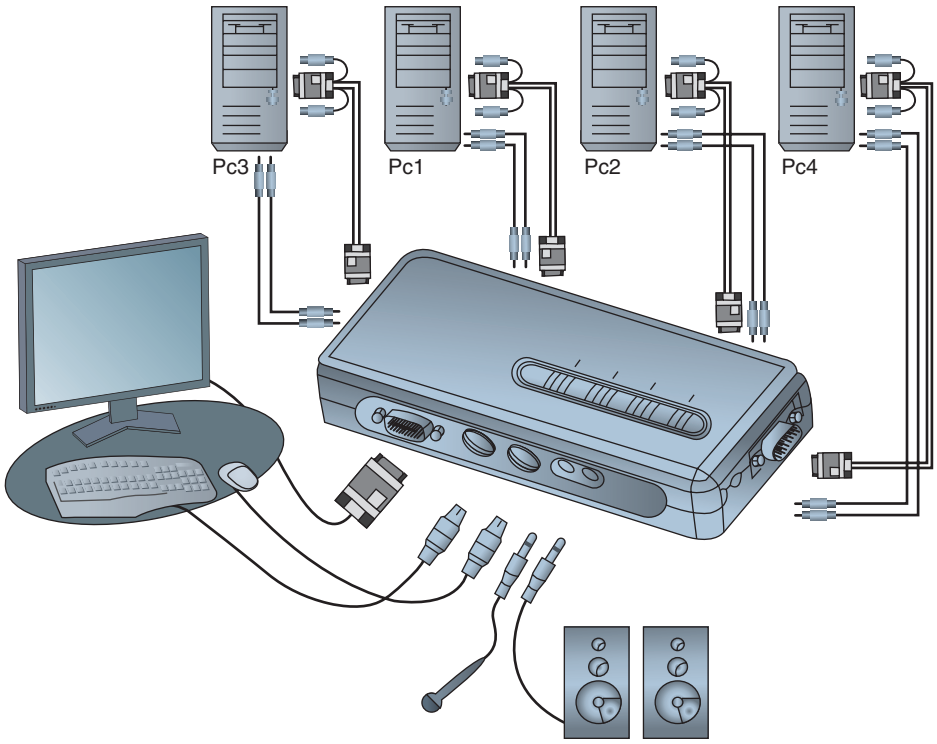

Figure 9-52 Hardware configuration for a four-port KVM switch that also supports audio
Courtesy: Course Technology/Cengage Learning

A+ Exam Tip Content for the A+ 220-701 Essentials exam ends here, and content on the A+ 220-702 Practical Application exam begins.

INSTALLING AND CONFIGURING I/O DEVICES AND PORTS

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You have just seen how to install several input devices. In this part of the chapter, we take hardware installations to the next level and learn how to configure and use ports on the motherboard and how to install expansion cards.

When installing hardware devices under Windows XP, you need to be logged onto the system with a user account that has the highest level of privileges to change the system. This type of account is called an administrative account. In Windows Vista, it is not necessary to

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be logged in with an administrative account because of the User Account Control (UAC) box. When the box appears, you can enter the password for an administrative account in the UAC box, and then Vista will allow you to proceed with the installation. You will learn more about administrative accounts and other less-privileged accounts in Chapter 19.

Other than USB devices, most hardware devices are monitored and managed using Device Manager. Therefore, we begin our discussion with learning to use Device Manager.

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USING DEVICE MANAGER

Device Manager (devmgmt.msc) is your primary Windows tool for managing hardware. It gives a graphical view of hardware devices configured under Windows and the resources and drivers they use. Using Device Manager, you can disable or enable a device, update its drivers, uninstall a device, and undo a driver update (called a driver rollback). For instance, when a device driver is being installed, Windows might inform you of a resource conflict, or the device simply might not work. You can use Device Manager as a useful fact-finding tool for resolving the problem. You can also use Device Manager to print a report of system configuration.

A+ Exam Tip The A+ 220-702 Practical Application exam expects you to know in what scenario it is appropriate to use Device Manager. You also need to know how to use the utility and how to evaluate its results.

To access Device Manager, use one of these methods:

- For Vista, click **Start**, right-click **Computer**, and then select **Properties** on the shortcut menu. The System window appears (see Figure 9-53). Click **Device Manager** and respond to the UAC box. The Device Manager window opens.
- For Windows XP, click **Start**, right-click **My Computer**, select **Properties** from the shortcut menu, and then select the **Hardware** tab from the System Properties window. Finally, click **Device Manager**.

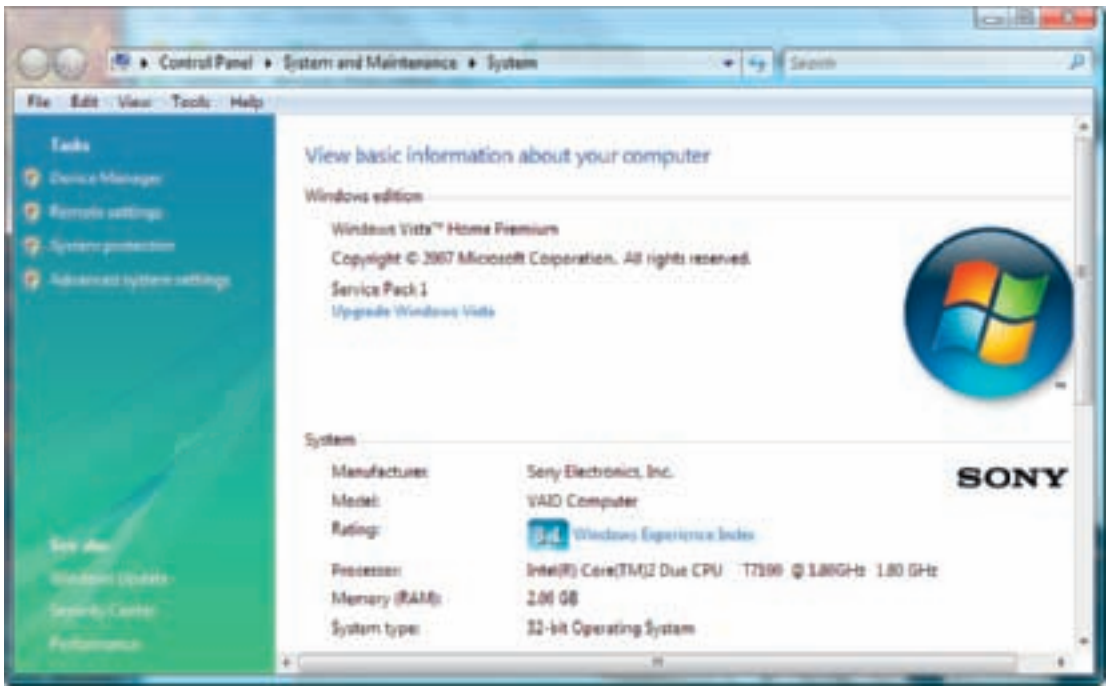

Figure 9-53 Windows Vista System window
Courtesy: Course Technology/Cengage Learning

- For Vista or XP, you can enter **Devmgmt.msc** in the Vista Start Search box or the XP Run box and press **Enter**. For Vista, respond to the UAC box.

Device Manager for Windows Vista is shown in Figure 9-54. Click a plus sign to expand the view of an item, and click a minus sign to collapse the view.

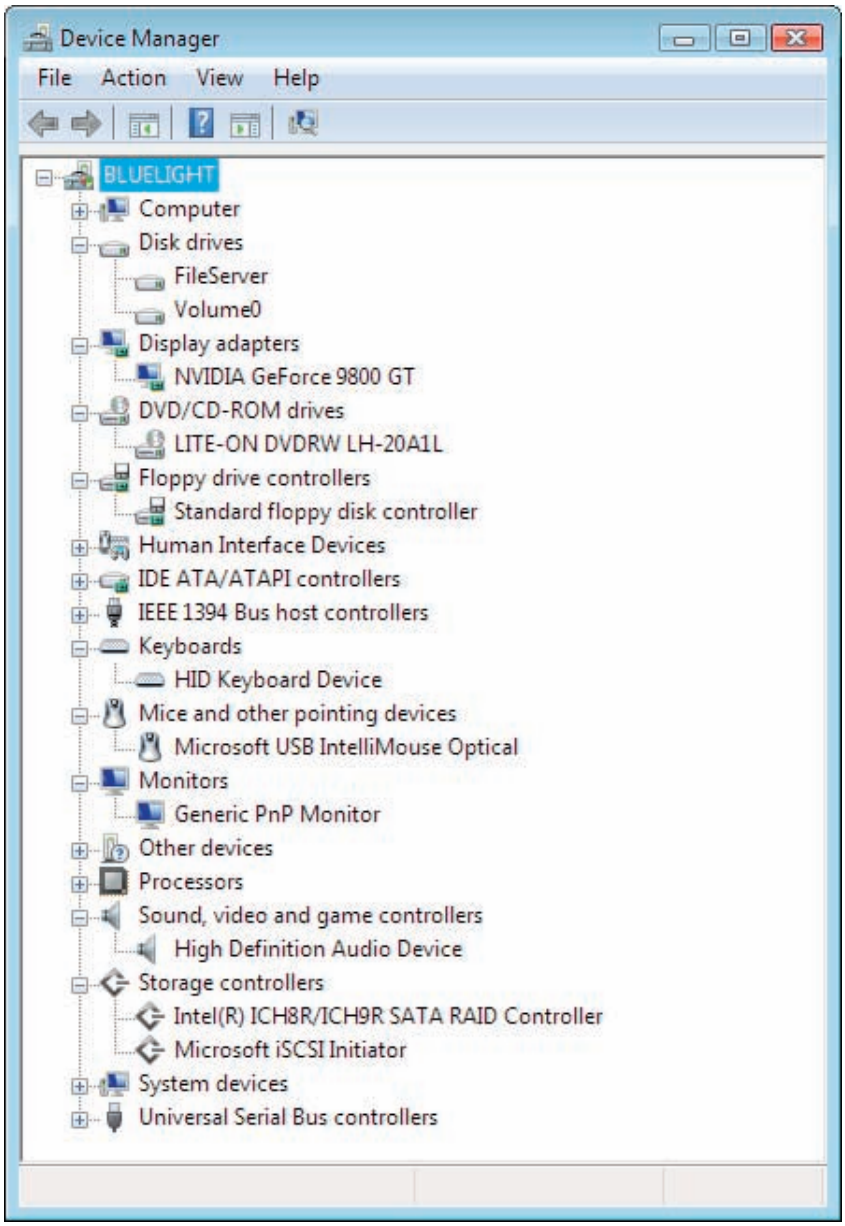

Figure 9-54 Device Manager lists installed devices
Courtesy: Course Technology/Cengage Learning

One thing you can do if you have a problem with an installed device is to use Device Manager to uninstall the device. Right-click the device and click **Uninstall** on the shortcut menu (see Figure 9-55). Then reboot and reinstall the device, looking for problems during the installation that point to the source of the problem. Sometimes reinstalling a device is all that is needed to solve the problem. Notice in Figure 9-55 that the device selected is a USB mouse. Sometimes USB devices are listed in Device Manager and sometimes they are not.

To find out more information about a device, right-click the device and select **Properties** on the shortcut menu. Figure 9-56 shows the properties box for the onboard audio controller. Many times, the source of a problem shows up in this window. Windows is reporting that the device cannot start and suggests how to search for a solution.

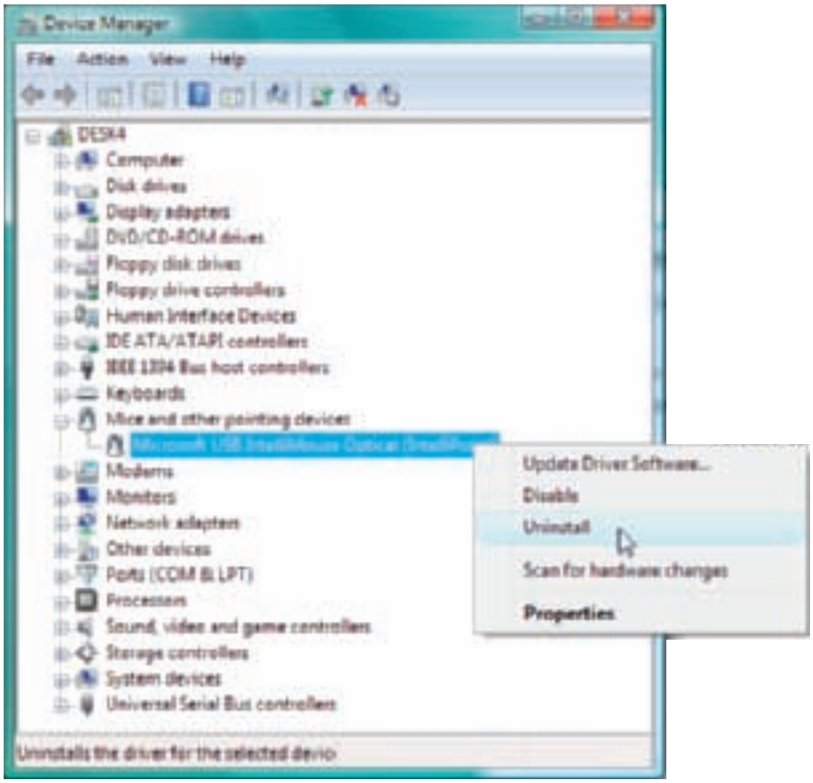

Figure 9-55 Use Device Manager to uninstall a device
Courtesy: Course Technology/Cengage Learning

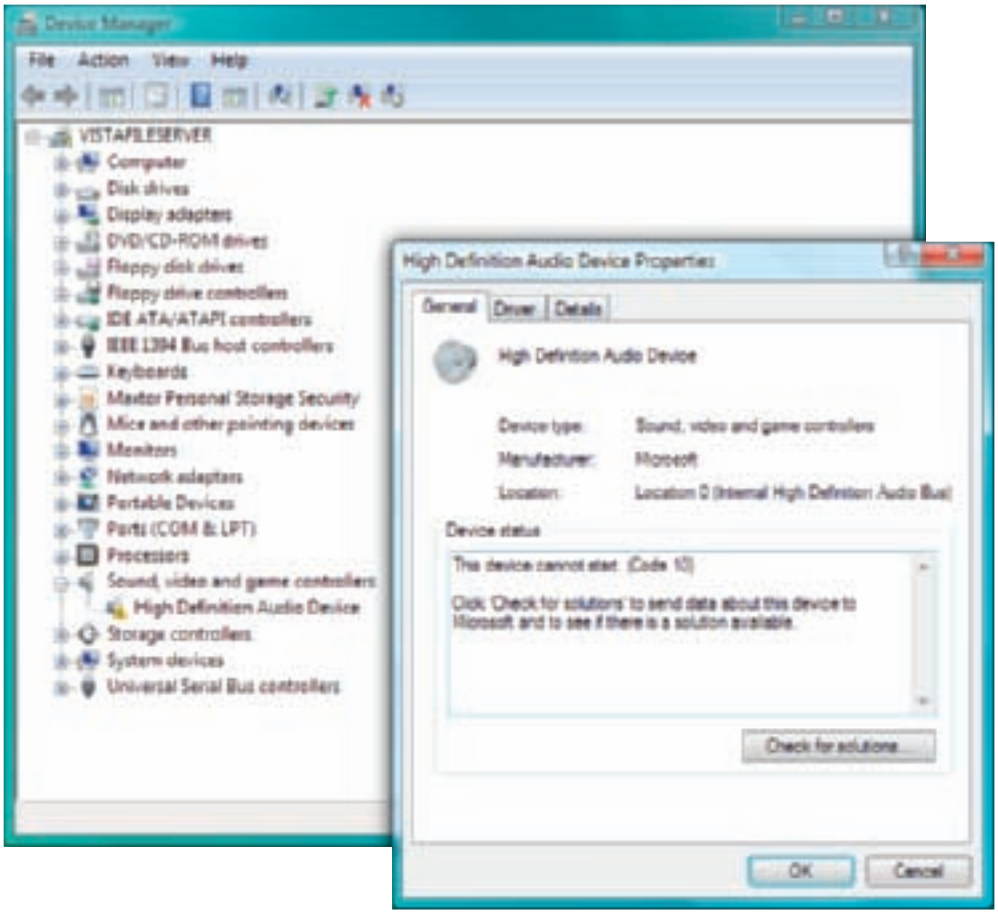

Figure 9-56 Windows reports an error with a device
Courtesy: Course Technology/Cengage Learning

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Another Properties box is shown in Figure 9-57; this one is for the network card. Notice the Diagnostics tab in the properties dialog box. If this tab is present, most likely you will find diagnostic software there that can be executed to test the device and report problems.

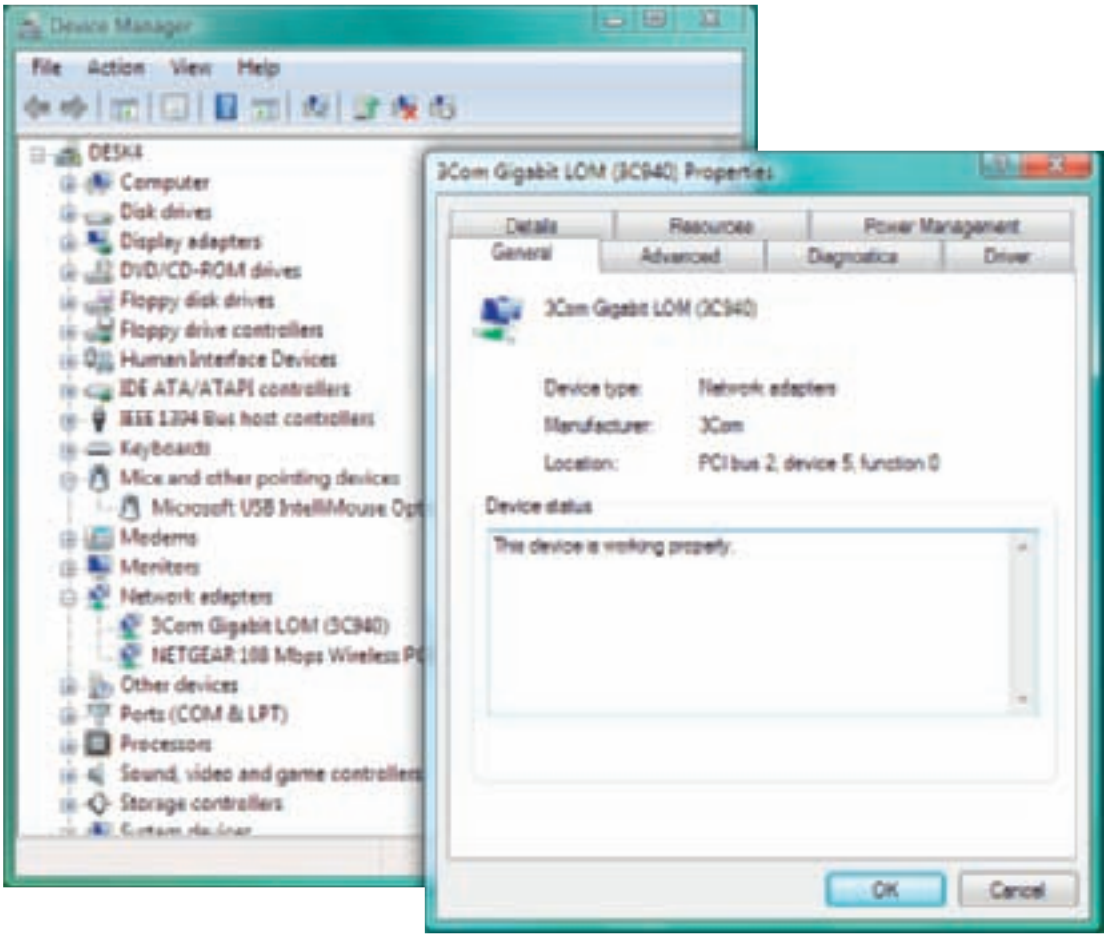

Figure 9-57 A device properties box in Device Manager can be used to report problems and test a device
Courtesy: Course Technology/Cengage Learning

Click the **Driver** tab (see Figure 9-58) to view details about the installed drivers, update the drivers, undo a driver update, disable, or enable a device. Notice in Figure 9-58 that the Driver tab shows the driver for the network card is not digitally signed. Compare this box to the Driver tab of a RAID controller properties box shown in Figure 9-59 where the driver is digitally signed.

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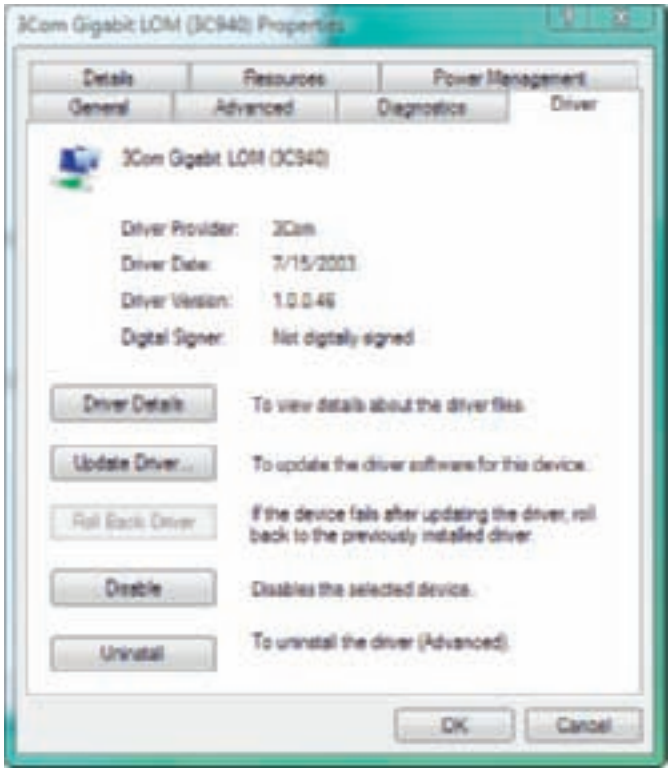

Figure 9-58 Manage the drivers for a device
Courtesy: Course Technology/Cengage Learning

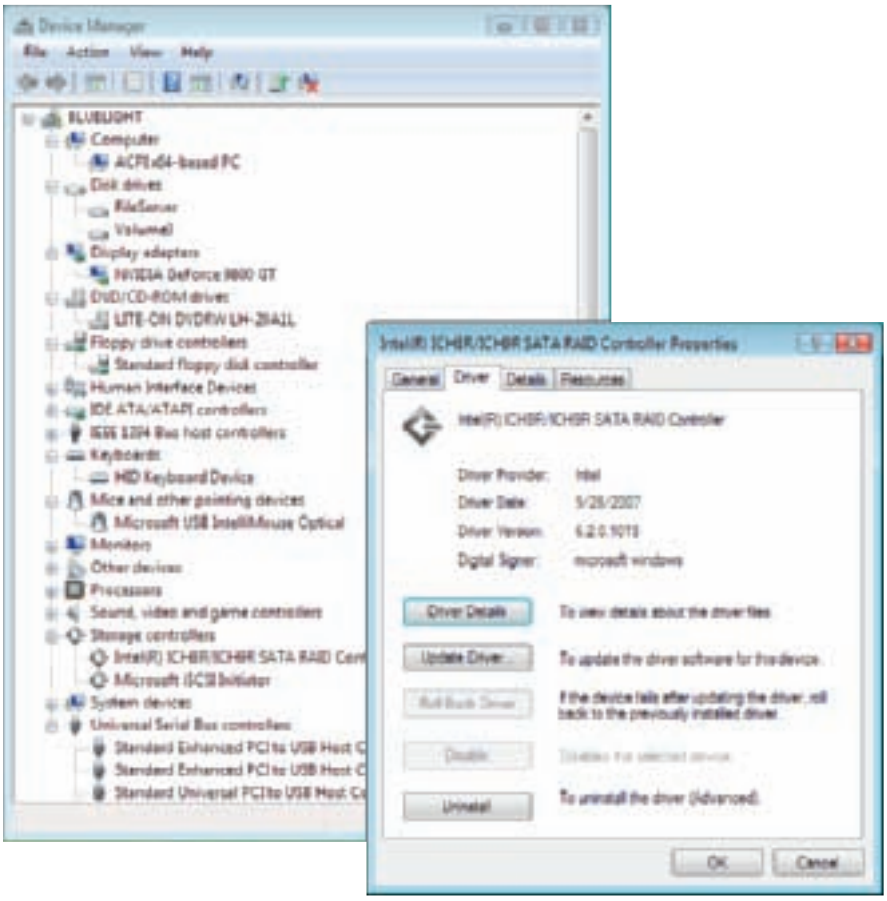

Figure 9-59 The driver for this installed RAID controller is digitally signed
Courtesy: Course Technology/Cengage Learning

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Now let's look at how to manage the ports on the motherboard.

USING PORTS ON THE MOTHERBOARD

Ports on the motherboard include sound, video, USB 1.1, USB 2.0, serial, IEEE 1394, parallel, network, modem, and PS/2 ports. Recall that ports on the motherboard can be disabled or enabled in BIOS setup. If you're having a problem with a port, check BIOS setup to make sure the port is enabled. For example, Figure 9-60 shows a BIOS setup screen where you can enable and disable the audio ports, 1394 (FireWire) port, LAN (network) port, Wi-Fi (wireless) connector, serial port, parallel port, and game port. Know that, for ports and expansion slots, BIOS setup recognizes the port or slot, but not the device or expansion card using that slot. Any device that shows up in BIOS setup should also be listed in Device Manager. However, not all devices listed in Device Manager are listed in BIOS setup.

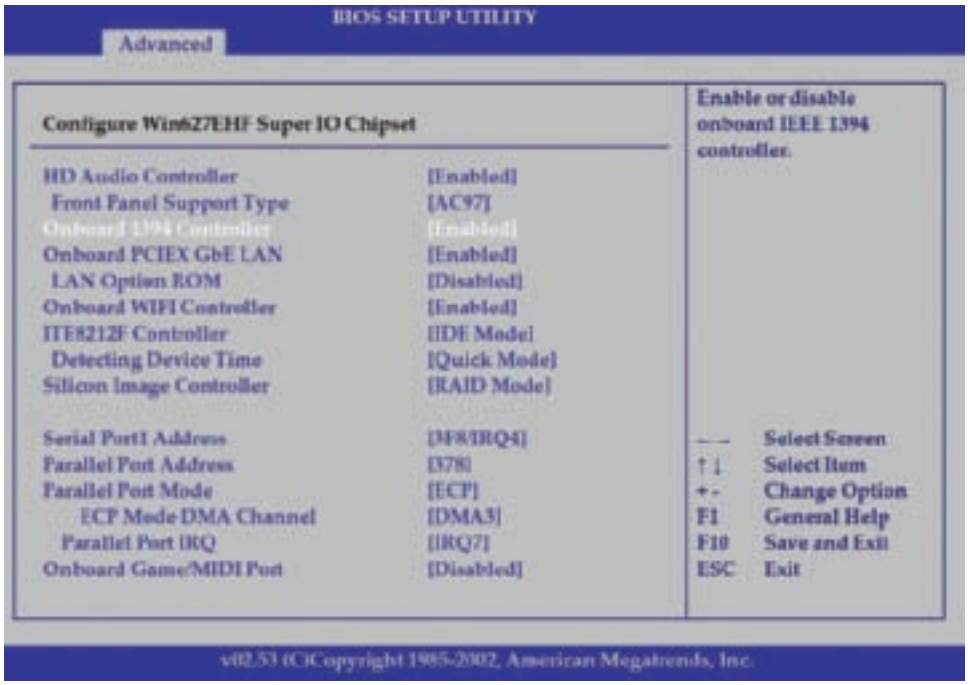

Figure 9-60 In BIOS setup, you can disable and enable motherboard ports and other components
Courtesy: Course Technology/Cengage Learning

When having a problem with a port, after you know the port is enabled in BIOS setup, turn to Device Manager to make sure it recognizes the port without an error. For example, in Figure 9-61, Device Manager reports no problems with the FireWire port or controller. If you are having problems with a motherboard port, don't forget to update the motherboard drivers that control the port.

Now let's look at the details of managing USB, FireWire, parallel, and serial ports.

USING USB AND FIREWIRE PORTS

Some USB and FireWire devices, such as a USB printer, require that you plug in the device before installing the drivers, and some devices require you to install the drivers before plugging in the device. For some devices, it doesn't matter which is installed first. Carefully read and follow the device documentation. For example, the documentation for one digital camera says that if you install the camera before installing the driver, the drivers will not install properly.

Before you begin the installation, make sure the drivers provided with the device are written for the OS you are using. For example, if you are about to install a USB scanner and the

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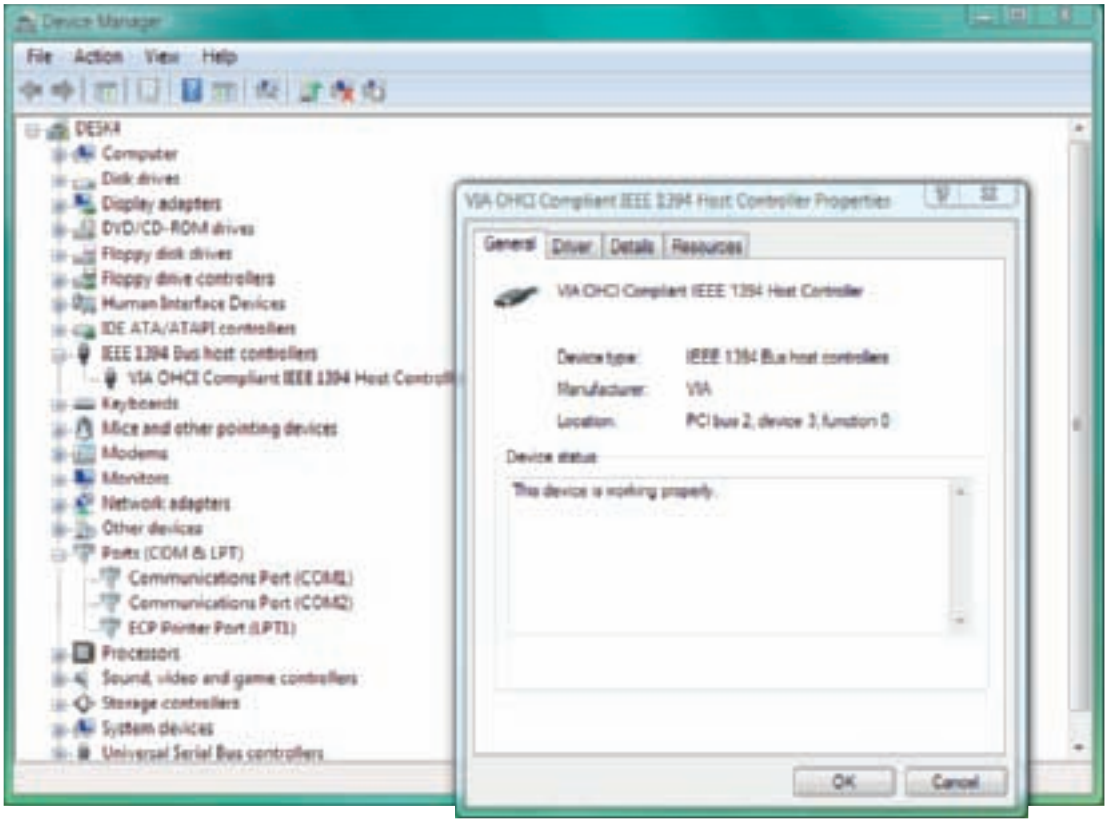

Figure 9-61 Device Manager reports no problems with the FireWire controller or port
Courtesy: Course Technology/Cengage Learning

documentation says the CD that is bundled with the scanner supports Windows 2000 and XP, know that these drivers will not work under Vista. Check the Web site of the scanner manufacturer to see if you can download Vista drivers. If you find them, download the driver file to your hard drive and double-click the file to install the Vista drivers.

Notes Using BIOS setup, you can enable or disable USB or FireWire ports and sometimes the options are there to configure a USB port to use Hi-Speed USB, original USB, or both.

To use a USB or FireWire port with Windows, follow these steps:

1. Verify that Device Manager recognizes that a USB or IEEE 1394 controller is present and reports no errors with the port. If the controller is not installed or is not working, reinstall the motherboard drivers for the port.
2. Read the device documentation to decide if you install the drivers first or plug in the device first.
3. If you plug in the device first, plug it into the FireWire or USB port. The Found New Hardware wizard appears and steps you through the installation of drivers.
4. If you need to install the drivers first, follow the documentation instructions to run a setup program on CD. It might be necessary to restart the system after the installation. After the drivers are installed, plug the device into the port. The device should immediately be recognized by Windows.
5. Install the application software to use the device. For example, a FireWire camcorder is likely to come bundled with video-editing software. Run the software to use the device.

Notes Some motherboards provide extra ports that can be installed in faceplate openings off the back of the case. For example, Figure 9-62 shows a module that has a game port and two USB ports. To install the module, remove a faceplate and install the module in its place. Then connect the cables from the module to the appropriate connectors on the motherboard.

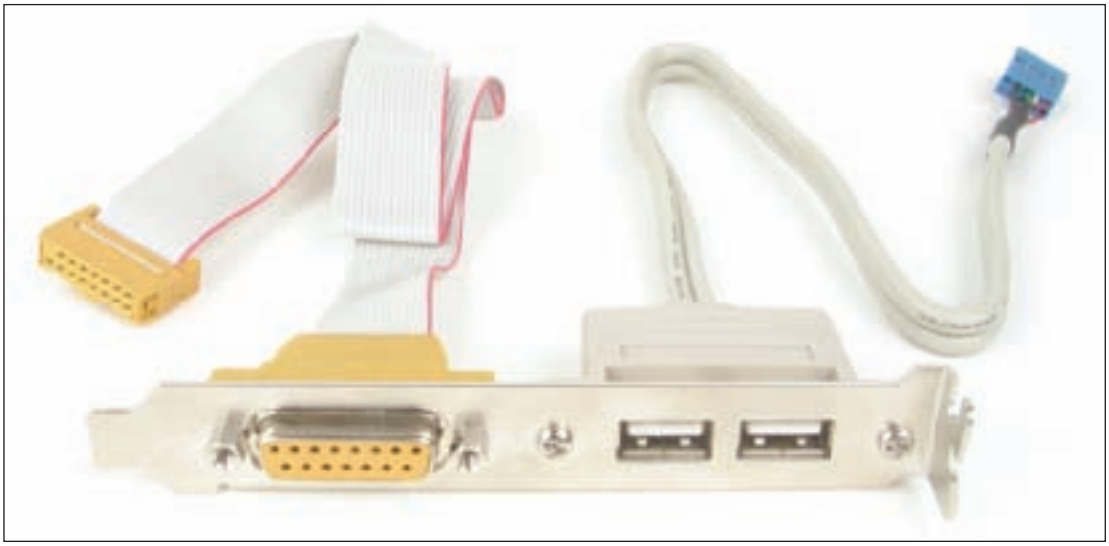

Figure 9-62 This connector provides two USB ports and one game port
Courtesy: Course Technology/Cengage Learning

APPLYING CONCEPTS

For motherboards that provide FireWire ports, the board might come with an internal connector for an internal FireWire hard drive. This connector can also be used for a module that provides additional FireWire ports off the back of the PC case. Figure 9-63 shows a motherboard with the pinouts of the FireWire connector labeled. The module is also shown in the figure. To install this module, remove a faceplate and install the module in its place. Then connect the cable to the motherboard connector.

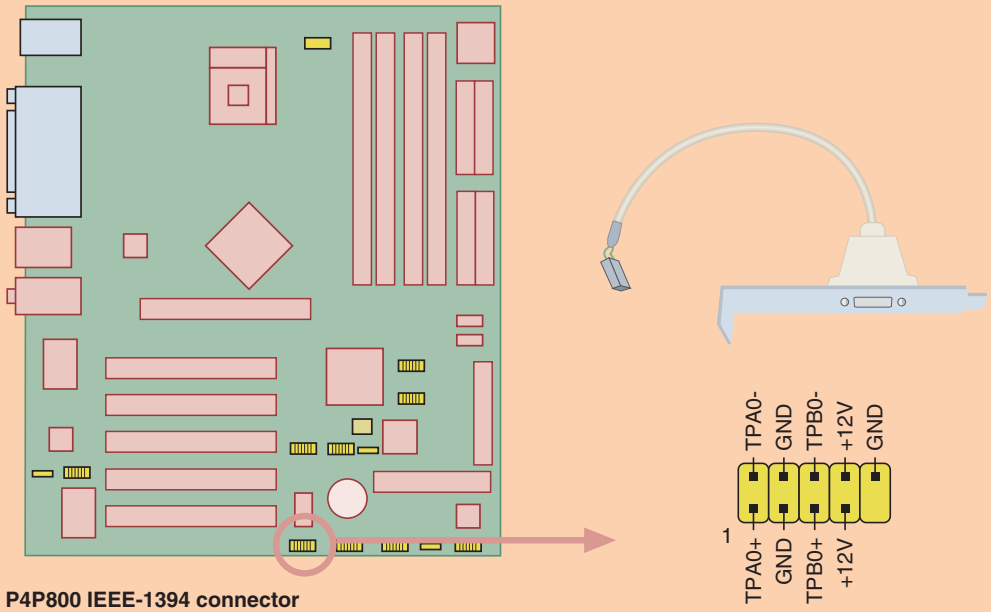

Figure 9-63 This motherboard has a 10-pin FireWire header that can be used for an internal FireWire hard drive or to provide an extra external FireWire port
Courtesy: Course Technology/Cengage Learning

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CONFIGURING PARALLEL PORTS

Older motherboards required you to configure parallel and serial ports to use certain hardware and OS resources and to avoid conflicts. However, motherboards today are much easier to configure. For example, the BIOS setup on one system to configure the parallel port is shown in Figure 9-64. Unless you are having a problem with the port or suspect a conflict with other hardware, keep the default setting of ECP. Recall that ECP uses a DMA channel. Allow setup to keep DMA3 unless you suspect a conflict with another device trying to use DMA. You can also select an **IRQ (interrupt request) line** for the port. BIOS manages these request lines that are used by a device to hail the CPU asking for data to be processed, and you do not need to change this value.

Figure 9-64 BIOS settings for a parallel port on one motherboard
Courtesy: Course Technology/Cengage Learning

Notes If you have trouble using a motherboard port, such as a serial, parallel, USB, or 1394 port, check BIOS setup to make sure the port is enabled. If you have problems with resource conflicts, try disabling ECP mode for the parallel port. EPP mode gives good results and does not tie up a DMA channel.

In Device Manager, a parallel port is known as LPT1: or LPT2:. The **LPT (Line Printer Terminal)** assignments refer to the system resources a parallel port will use to manage a print job. Check Device Manager for errors. In Figure 9-65, note the parallel port is listed as ECP Printer Port (LPT1).

CONFIGURING SERIAL PORTS

Looking back at Figure 9-64, you can see the two serial ports on this system can be configured to use certain resources. The first serial port is using 3F8/IRQ4 and the second serial port is using 2F8/IRQ3. The first values (3F8 and 2F8) indicate I/O addresses used by the ports,

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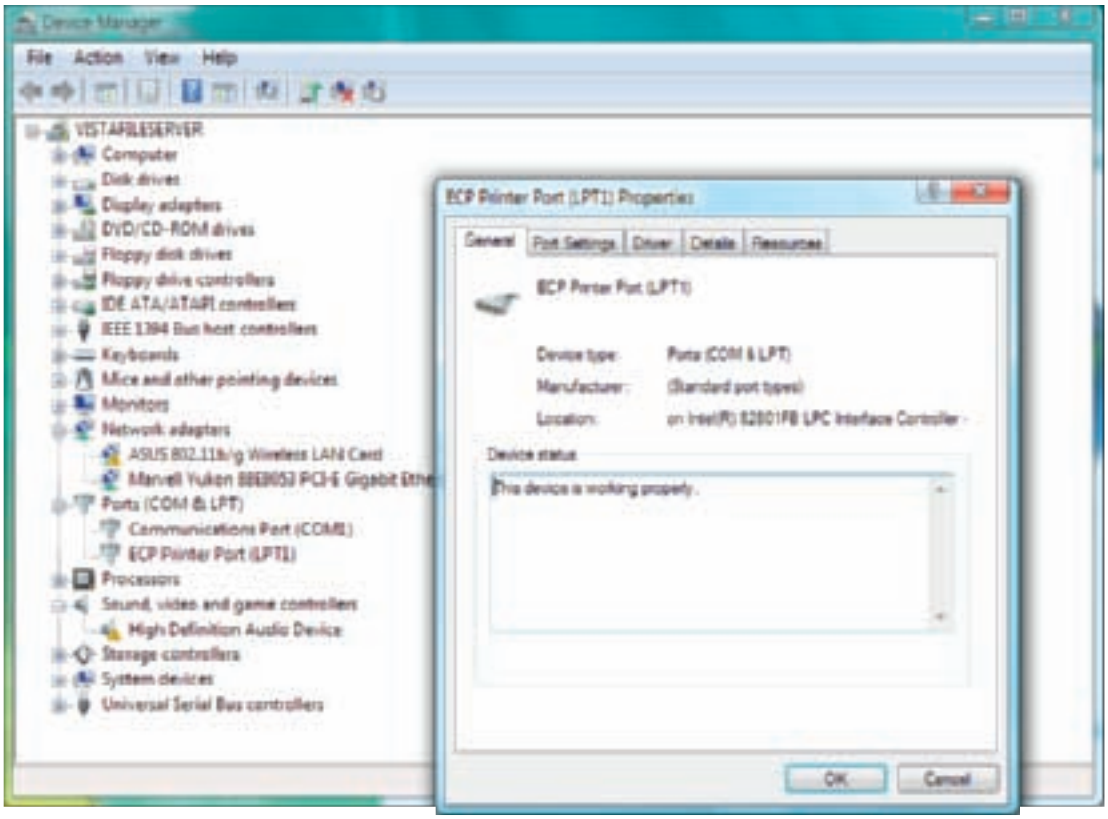

Figure 9-65 The parallel port in Device Manager is known as the LPT port
Courtesy: Course Technology/Cengage Learning

which are numbers the CPU uses to hail the port. The second values (IRQ4 and IRQ5) are lines the port uses to hail the CPU. For most situations, these default settings are appropriate and will never need changing. In Device Manager, the serial ports are known as COM ports. Settings for a serial port can be seen in the properties box for the port on the Port Settings tab (see Figure 9-66). These settings are used by modem cards that are installed in expansion slots on the system. The default values shown in Figure 9-66 are correct for modem settings and should not be changed.

INSTALLING AND CONFIGURING ADAPTER CARDS

In this part of the chapter, you will learn to install and configure adapter cards. These cards include a video card, sound card, storage controller card, I/O card, wired or wireless network card, or capture card. Regardless of the type of card you are installing, when preparing to install an adapter card, be sure to verify and do the following:

- *Verify the card fits an empty expansion slot*. Recall from Chapter 5 that there are several AGP, PCI, and PCI Express standards. Know that shorter PCIe cards can be installed in longer PCIe slots. Also, know that you can install a 32-bit PCI card into a longer 64-bit PCI slot. In these cases, the extended end of the long PCIe or PCI slot is unused. For AGP and PCI cards, you must match the notches on the card to the keys in the AGP or PCI slot so that the voltage requirements of the card will match the voltage provided by the slot. And one more tip: To help with air flow, try to leave an empty slot between cards. Especially try to leave an empty slot beside the video card, which puts off a lot of heat.

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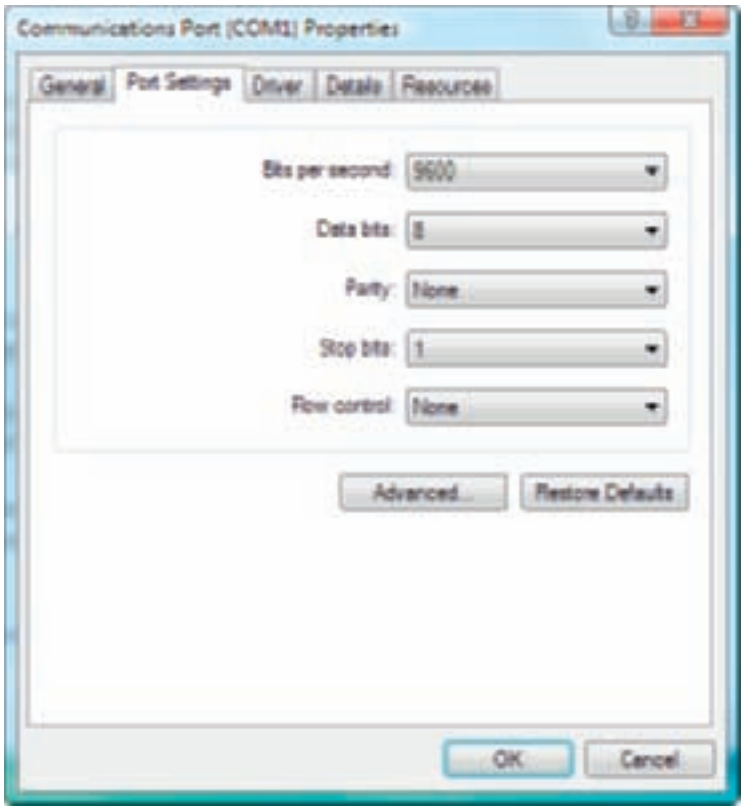

Figure 9-66 Port settings for a serial port as reported by Device Manager
Courtesy: Course Technology/Cengage Learning

- *Verify the device drivers for your OS are available*. Drivers written for one OS will not work with another. Check the card documentation and make sure you have the drivers for your OS. It might be possible to download drivers for your OS from the Web site of the card manufacturer.
- *Back up important data that is not already backed up*. How to perform backups is covered in Chapter 13.
- *Know your starting point*. Know what works and doesn't work on the system. Can you connect to the network and the Internet, print, and use other installed adapter cards without errors?

Here are the general directions to install an adapter card. They apply to any type card.

1. Read the documentation that came with the card. For most cards, you install the card first and then the drivers, but some adapter card installations might not work this way.
2. If you are installing a card to replace an onboard port, access BIOS setup and disable the port.
3. Wear a ground bracelet as you work to protect the card and the system against ESD.
4. Shut down the system, unplug power cords and cables, and press the power button to drain the power. Remove the computer case cover.
5. Locate the slot you plan to use and remove the faceplate cover from the slot if one is installed. Sometimes a faceplate punches or snaps out, and sometimes you have to remove a faceplate screw to remove the faceplate. Remove the screw in the top of the expansion slot. Save the screw; you'll need it later.

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6. Remove the card from its antistatic bag and insert it into the expansion slot. Be careful to push the card straight down into the slot, without rocking the card from side to side. Rocking it from side to side can widen the expansion slot, making it difficult to keep a good contact. If you have a problem getting the card into the slot, resist the temptation to push the front or rear of the card into the slot first. You should feel a slight snap as the card drops into the slot. Later, if you find out the card does not work, most likely it is not seated snuggly into the slot. Check that first and then, if possible, try a different slot.
7. Insert the screw that anchors the card to the top of the slot (see Figure 9-67). Be sure to use this screw. If it's not present, the card can creep out of the slot over time.

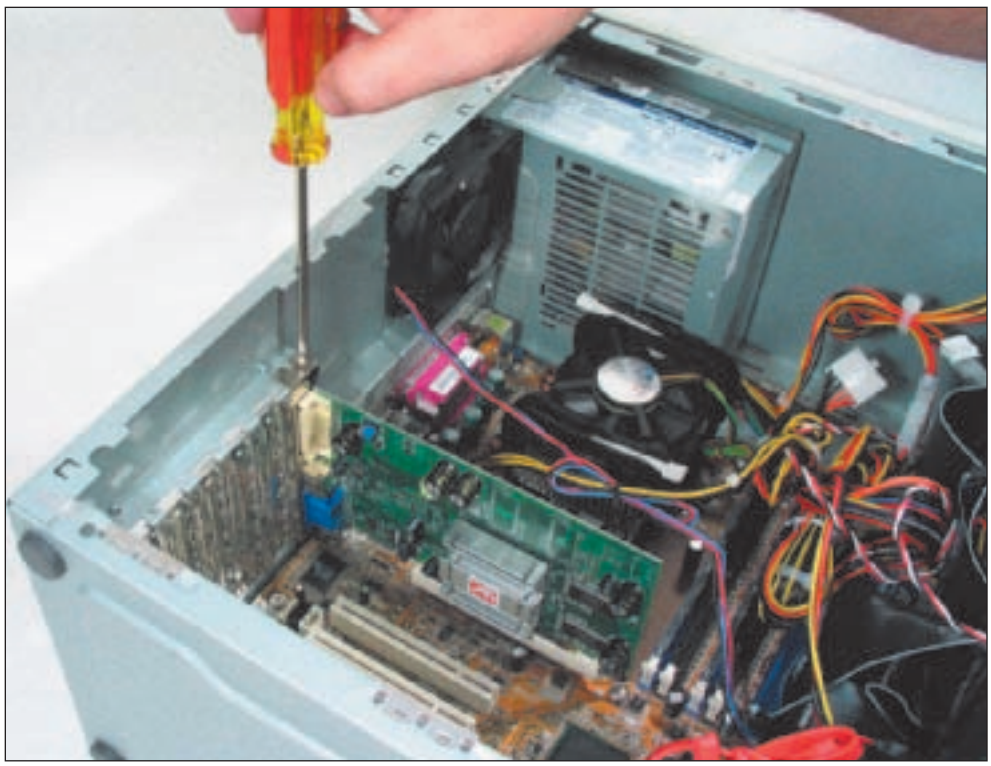

Figure 9-67 Secure the card to the case with a single screw
Courtesy: Course Technology/Cengage Learning

8. Replace the case cover, power cord, and other peripherals. (If you want, you can leave the case cover off until you've tested the card, in case it doesn't work and you need to reseat it.)
9. Start the system. When Windows starts, Windows Plug and Play should detect a new hardware device is present. The Found New Hardware wizard should launch and you can use it to complete the installation.

Now let's look at the specific details when installing a FireWire controller card, a video card, and a SATA controller card that supports RAID.

A+ Exam Tip The A+ 220-702 Practical Application exam expects you to know how to install and configure these adapter cards: graphics card, RAID and eSATA storage controller card, and I/O controller cards that provide FireWire, USB, parallel, and serial ports. All these adapter card installations are covered in this part of the chapter.

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HOW TO INSTALL A FIREWIRE CONTROLLER CARD

The FireWire controller card shown earlier in the chapter in Figure 9-12 uses a PCI slot and has a power connector to provide extra power to the FireWire ports. Do the following to install the card:

1. Follow the general directions given earlier to install the card in a PCI slot.
2. Connect the power cord to the card and to a 4-pin power connector from the power supply.
3. Start Windows, which automatically detects the card and installs its own embedded Windows IEEE 1394 drivers. See Figure 9-68 for Vista and Figure 9-69 for XP.

Figure 9-68 Vista installs embedded Windows drivers
Courtesy: Course Technology/Cengage Learning

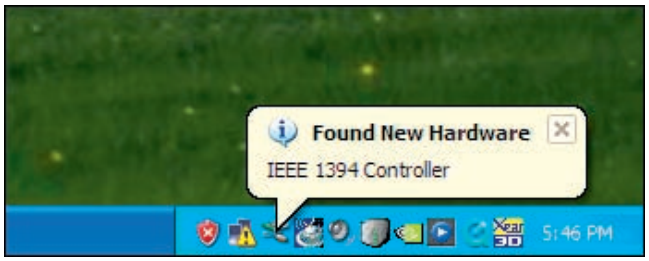

Figure 9-69 Windows XP finds the IEEE 1394 controller and installs drivers
Courtesy: Course Technology/Cengage Learning

4. To verify the installation, go to Device Manager and look for the new IEEE 1394 Host Controller installed and listed with no errors.
5. You can now plug up FireWire devices to the ports on the card.

If you later have problems with the card, you can use the driver CD to install the drivers that came with the device. For this device, the CD contains drivers for 32-bit and 64-bit Vista and XP. Locate the driver file on the CD for the OS you are using and double-click the file. Follow the directions on-screen to install the drivers.

HOW TO INSTALL A VIDEO CARD

Recall that Windows has embedded video drivers so that you can use video even if the manufacturer drivers are not installed. However, to get the best performance from the card and to be able to use all its features, always install the manufacturer drivers. Follow these steps to install a video card and its drivers:

Video
Installing a Video Card

1. If the video card is intended to replace an onboard video port, go into BIOS setup and disable the onboard video port.
2. Follow the general steps given earlier to install the video card in a PCI, AGP, or PCIe slot. AGP and PCIe slots use a retention mechanism in the slot to help stabilize a heavy

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video card (see Figure 9-70). Check your motherboard documentation for specific instructions to insert the card in this type slot. You might have to use one finger to push the stabilizer to the side as you push the card into the slot. Alternately, the card might snap into the slot and then the retention mechanism snaps into position. Later, if you need to remove the card, use one finger to push the retention mechanism down or to the side and then remove the card. Figure 9-71 shows a PCIe video card installed in a PCIe x16 slot. Notice the fan and heat sink on the card to keep it cool.

Figure 9-70 A white retention mechanism on a PCIe x16 slot pops into place to help stabilize a heavy video card
Courtesy: Course Technology/Cengage Learning

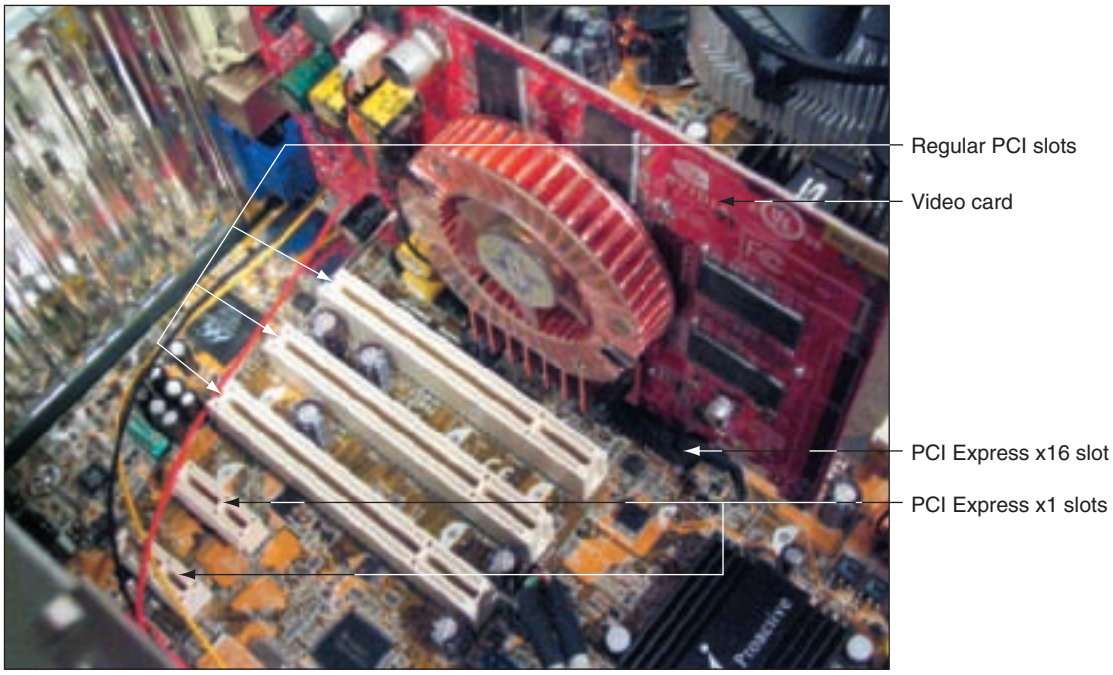

Figure 9-71 A PCIe video card installed in a PCIe x16 slot
Courtesy: Course Technology/Cengage Learning

3. If the video card has a 6-pin or 8-pin PCIe power connector, connect a power cord from the power supply to the connector (see Figure 9-72). If the power supply does not have the right connector, you can buy an inexpensive adapter to convert a 4-pin Molex connector to a PCIe connector.
4. When Windows starts up, it will launch the Found New Hardware Wizard (see Figure 9-73). You can install the embedded generic Windows video drivers by allowing the wizard to complete. However, to get the best performance from the card, cancel the wizard (see Figure 9-74) so you can use the drivers that came with the card.

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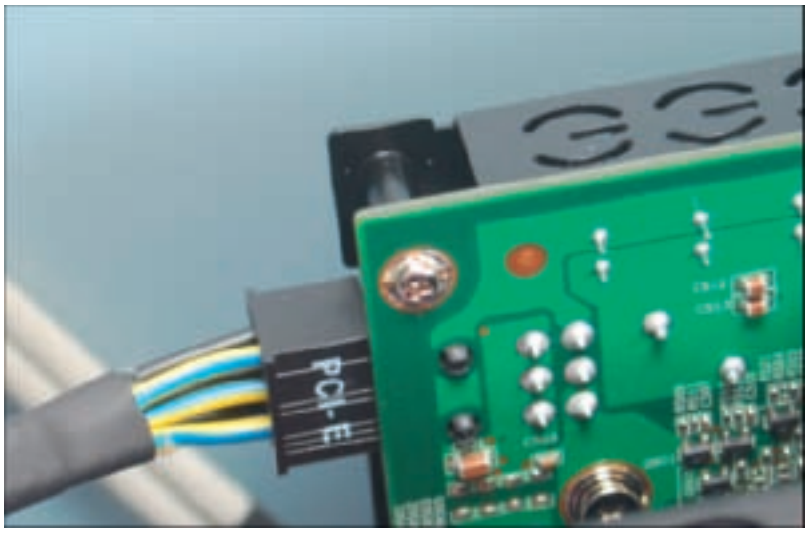

Figure 9-72 Connect a power cord to the PCIe power connector on the card
Courtesy: Course Technology/Cengage Learning

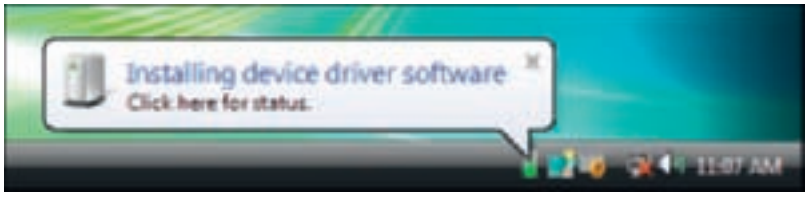

Figure 9-73 The Vista Found New Hardware Wizard attempts to install device drivers
Courtesy: Course Technology/Cengage Learning

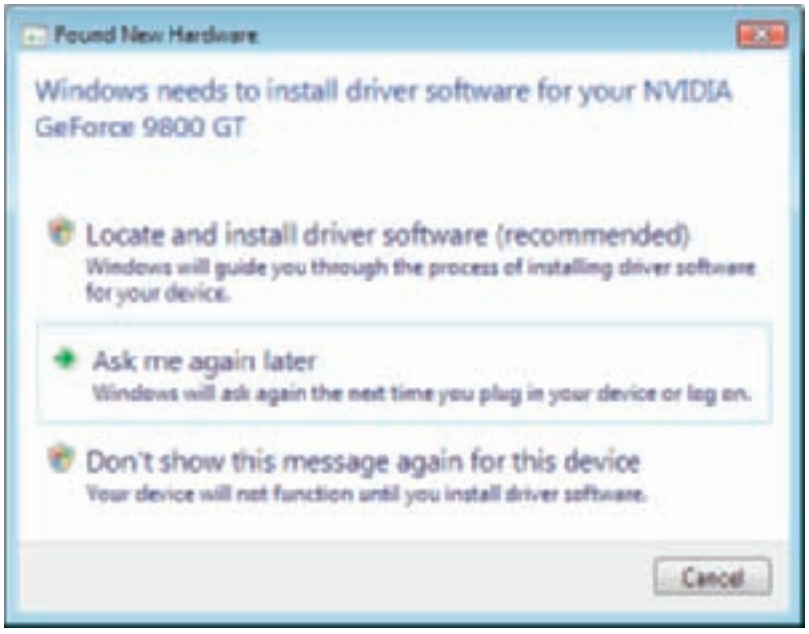

Figure 9-74 Cancel the automatic Windows installation
Courtesy: Course Technology/Cengage Learning

5. Insert the CD that came bundled with the card and launch the setup program on the CD. The card documentation will tell you the name of the program (examples are Setup.exe and Autorun.exe). Figure 9-75 shows the opening menu for one setup program. Click **Install Video Drivers** and follow the on-screen instructions to install the drivers.

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Figure 9-75 Opening menu to install video drivers
Courtesy: Course Technology/Cengage Learning

6. During the installation, Windows will ask you if you want to install the drivers. If the Microsoft Windows Hardware Quality Labs (WHQL) have certified the drivers, the Vista message will look like the one in Figure 9-76. (Later in the chapter, you will see a message indicating drivers are not certified by Microsoft.) Even though drivers have not been certified by Microsoft, it is safe to click **Install this driver software anyway** to continue with the installation.

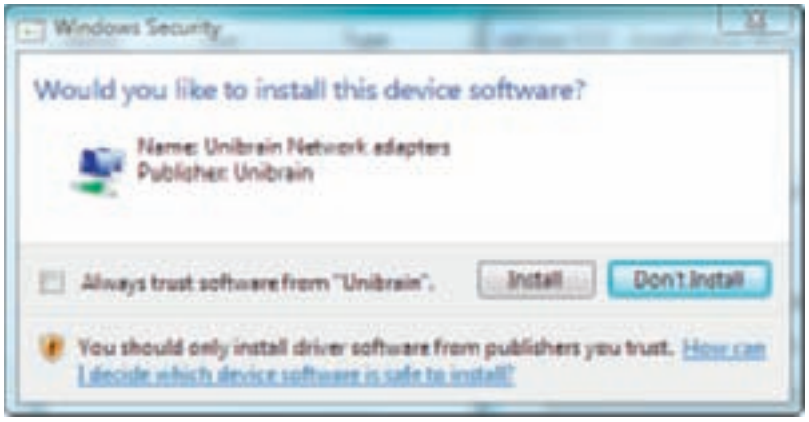

Figure 9-76 Windows recognizes the drivers and asks for your permission to install them
Courtesy: Course Technology/Cengage Learning

7. After the drivers are installed, use the Vista Display Settings or the XP Display Properties window to check the resolution and refresh rate for the monitor.

A+ Exam Tip The A+ IT 220-702 Practical Application exam expects you to know how to install a video card.

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When you install a video card, here is a list of things that can go wrong and what to do about them:

1. *When you first power up the system, you hear a whining sound*. This is caused by the card not getting enough power. Make sure a 6-pin or 8-pin power cord is connected to the card if it has this connector. The power supply might be inadequate.
2. *When you first start up the system, you see nothing but a black screen*. Most likely this is caused by the onboard video port not being disabled in BIOS setup. Disable the port.
3. *When you first start up the system, you hear a series of beeps*. BIOS cannot detect a video card. Make sure the card is securely seated. The video slot or video card might be bad.
4. *Error messages about video appear when Windows starts*. This can be caused by a conflict in onboard video and the video card. Try disabling onboard video in Device Manager.
5. *Games crash or lock up*. Try updating drivers for the motherboard, the video card, and the sound card. Also install the latest version of DirectX. Then try uninstalling the game and installing it again. Then download all patches for the game.

Notes When you match a monitor to a video card, a good rule of thumb is to match a low-end video card to a low-end monitor, a midrange video card to a midrange monitor, and a high-end video card to a high-end monitor, to get the best performance from both devices. However, you can compare the different features of the video card to those of the monitor, such as the resolutions and the refresh rates supported.

Installing Two Video Cards

For extreme graphics performance, you can use SLI or CrossFire to install two or more video cards in a system. For two video cards, you'll need a motherboard with two PCIe x16 slots and two matching video cards. The board and cards must support SLI or CrossFire. Follow these steps to install the cards using SLI by NVIDIA (CrossFire installs about the same way):

1. Install the first video card in the first PCIe x16 slot (the slot closest to the processor). Boot up the system and make sure the display is working. Install the drivers for the video card from the CD that came with the card.
2. Power down the system and install the second video card in the second PCIe x16 slot. Don't forget to connect a power cord to the card if it has the 6-pin or 8-pin power connection (see Figure 9-77). You might be curious about the ribbon cable in the photo that runs over the two cards. It's connecting the front panel switches and lights to the front panel header. The cable is so short it barely reaches.
3. Leave the monitor cable connected to the first card. Reboot and install the drivers for the second video card. After this installation, Device Manager should report two video cards installed with no problems (see Figure 9-78).
4. To configure the video cards to work in tandem, open the video adapter utility. The easiest way to open the utility is to right-click the desktop and select **NVIDIA Control Panel** from the shortcut menu (refer back to Figure 9-21). For this particular utility, select **Manage 3D settings** in the left pane and select **Multiple display performance mode** in the right pane, as shown in Figure 9-79.

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Figure 9-77 Two video cards installed in a system
Courtesy: Course Technology/Cengage Learning

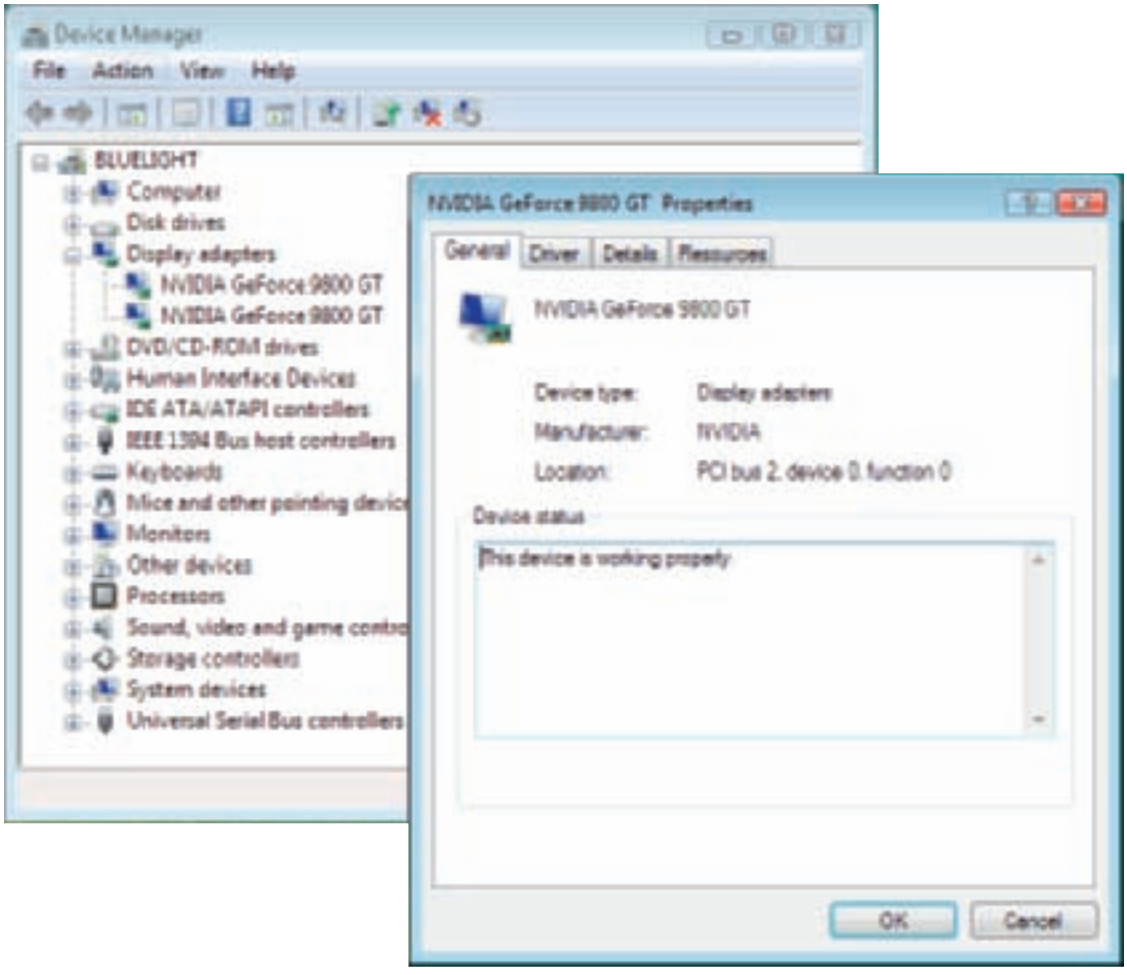

Figure 9-78 Two video cards are installed
Courtesy: Course Technology/Cengage Learning

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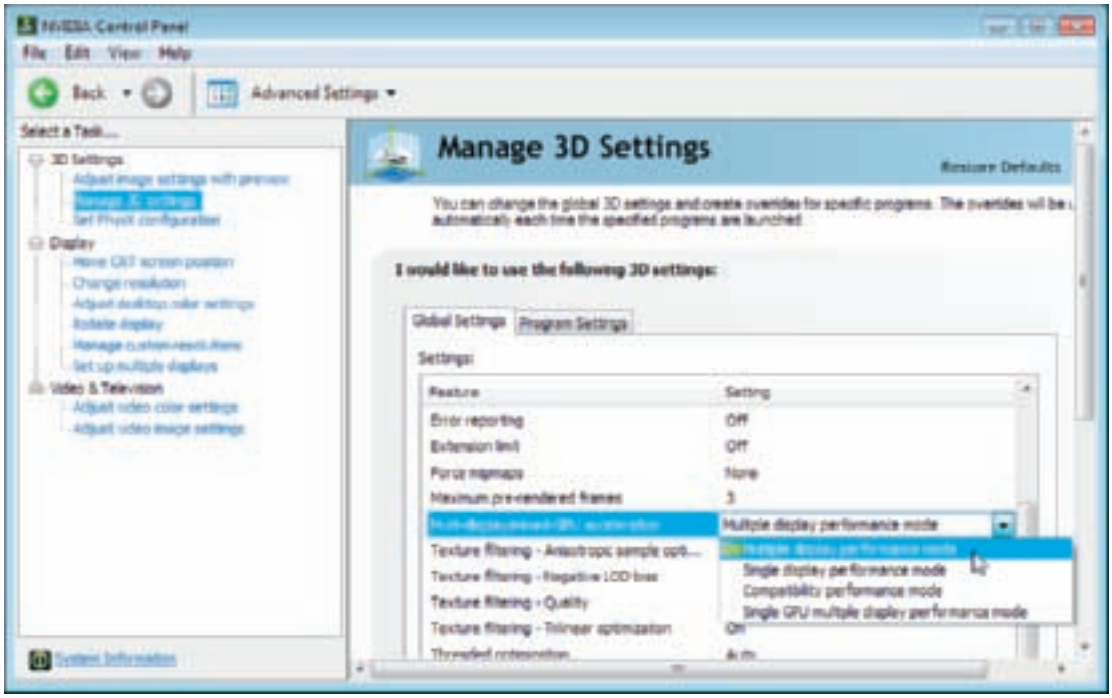

Figure 9-79 Configure the two video cards to work in tandem
Courtesy: Course Technology/Cengage Learning

5. Test the graphics to see if performance improves. If you believe performance should be better than it is, you can install an optional SLI bridge (see Figure 9-80). Connect each side of the SLI bridge to the gold connectors at the top of each SLI-ready video card. The SLI bridge improves performance because the cards can communicate by way of the bridge as well as by way of the PCIe slots.

Figure 9-80 SLI bridge is used to improve communication between two SLI video cards
Courtesy: Course Technology/Cengage Learning

HOW TO INSTALL A SATA, ESATA, AND RAID STORAGE CONTROLLER CARD

Installing and configuring a storage controller card that manages hard drives connected to ports on the card can be a little more complex than other adapter card installations. Not only do you have to install drivers to control the SATA and eSATA connectors on the card, but you might also have to install a utility program to manage a RAID array.

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As with all installations, follow the manufacturer's specific instructions for installing and configuring the card. Here are some general guidelines to install and configure a storage controller card to be used by drives that are not holding the Windows installation:

1. Following instructions given earlier in the chapter, install the controller card in an empty expansion slot. Attach one or more drives to the card SATA connectors.
2. Boot the computer. The Found New Hardware wizard finds the card and displays the message shown in Figure 9-81.

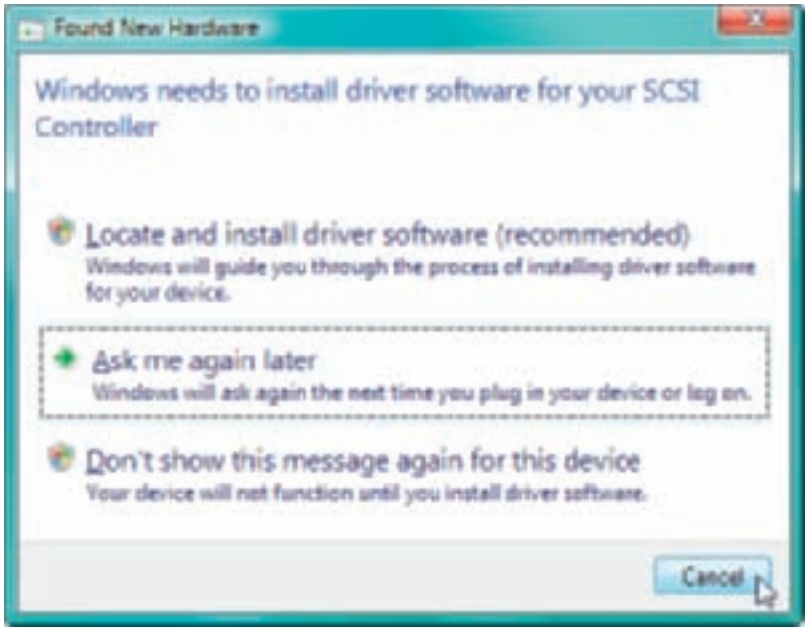

Figure 9-81 Vista wants to install drivers for the device it just found
Courtesy: Course Technology/Cengage Learning

3. For most installations, select **Locate and install driver software (recommended)**. However, if the controller card documentation says to cancel the Windows installation and use the Setup program on the driver CD instead, click **Cancel**.
4. If you are using the Windows installation method, Windows displays the message in Figure 9-82. Insert the card's driver CD and click **Next**. (Notice in Figure 9-81 that Vista believes it is installing a SCSI host adapter when, in fact, it is installing a SATA controller. The confusion will clear up after the installation.) If the controller card supports RAID, you might need to choose between non-RAID and RAID drivers.
5. If you are using the manufacturer installation routine, insert the driver CD and locate the Setup.exe program. Notice in Figure 9-83 ten folders on a CD listed on the right side of the screen. Each folder contains a Setup program and drivers for ten controller card models that this one CD supports. Look for your model number printed on the adapter card box. Double-click **Setup.exe** in your model's folder, respond to the UAC box, and follow the instructions on-screen to complete the installation.
6. During either the Windows installation or the manufacturer installation, if Windows detects the device drivers have not been certified by Microsoft, the warning message in Figure 9-84 appears. To continue the installation, click **Install the driver software anyway**.
7. After the installation, you will probably be prompted to restart the system. If so, do that now.

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Figure 9-82 Insert the drive CD to continue the installation
Courtesy: Course Technology/Cengage Learning

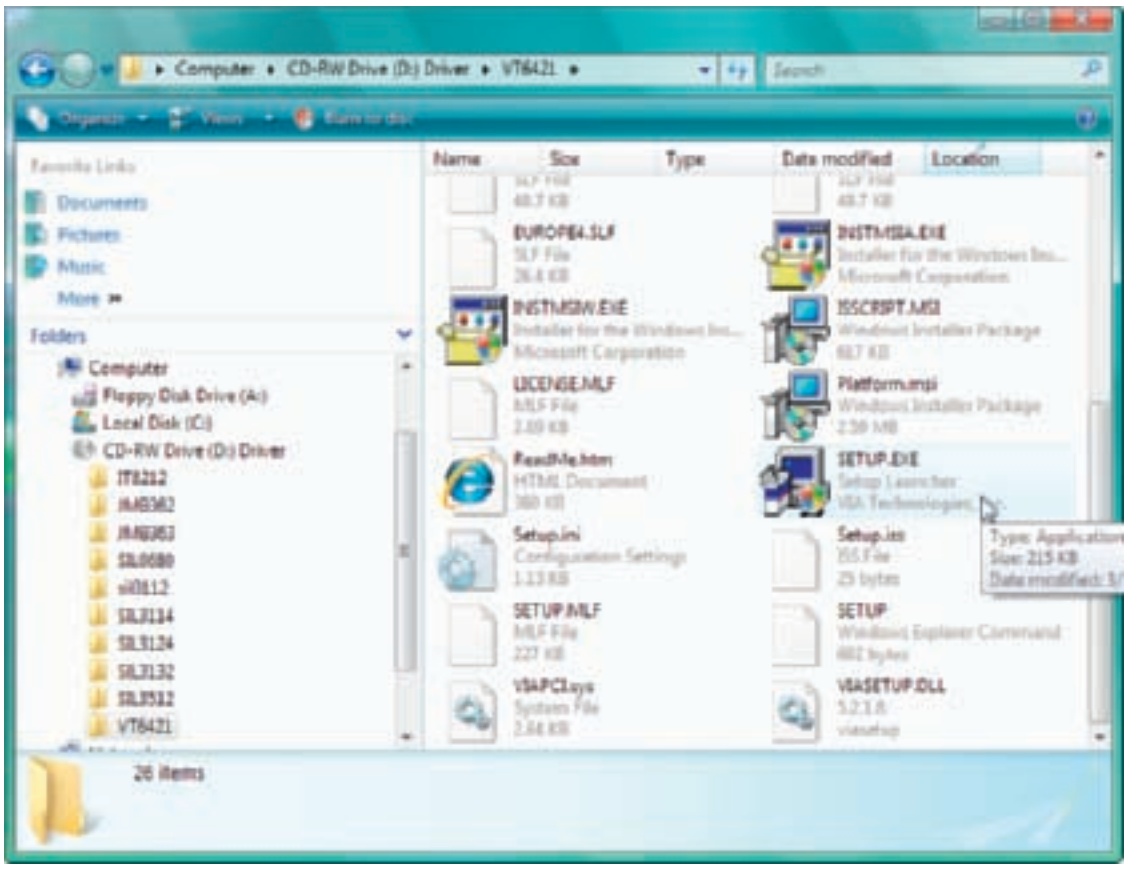

Figure 9-83 Locate the correct folder containing the Setup program on CD
Courtesy: Course Technology/Cengage Learning

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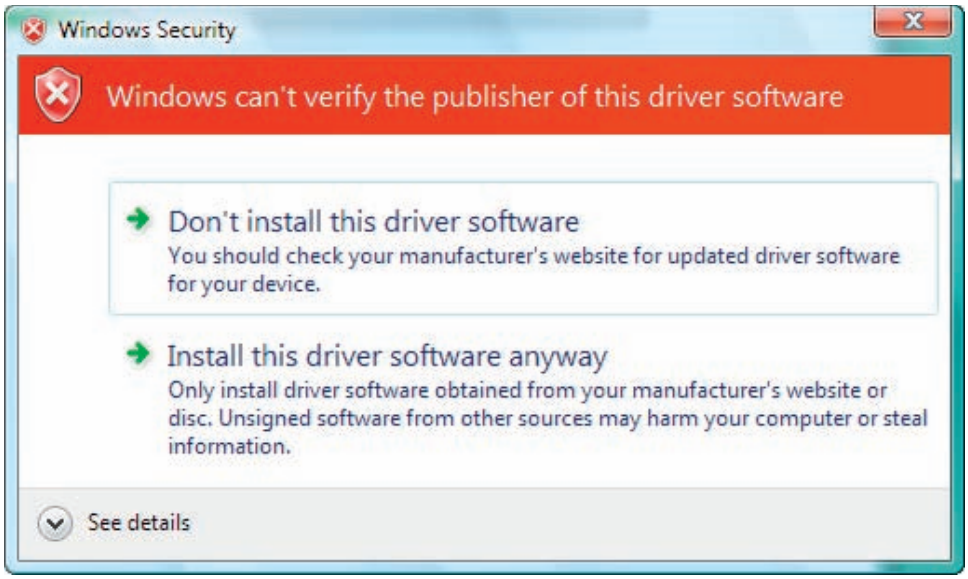

Figure 9-84 Windows warns drivers are not Microsoft certified
Courtesy: Course Technology/Cengage Learning

8. If you want to create a RAID array using the card, you might need to install a RAID utility to manage the array. The card documentation will tell you which folder on the CD contains the utility setup program. Find the setup program and double-click it to install the utility. You can then use it to create and monitor the RAID array. You will have to select the hard drives used in the array, the type of RAID (0, 1, or 5), and the amount of space on each drive devoted to the array (same for each drive). Chapter 8 gives more information about configuring RAID.

Notes Suppose you have a hard drive that is intended to be installed inside a computer case and you want to install it outside the case as an external drive. If you have an available eSATA external port, you can use a protective **hard drive dock** that will house and protect a hard drive outside the computer case. These devices are hot-pluggable and sometimes called a toaster because that's what they look like (see Figure 9-85). Plug the toaster into a power outlet and pop your internal hard drive into the toaster. Use the toaster's SATA cable to connect the drive to an eSATA port on your system. But be cautious: some toasters are not reliable. Be sure to read several online reviews about a toaster before you buy one.

Sometimes the controller card will manage the hard drive on which Windows is installed. Here are three situations you might encounter and how to handle them:

- *New Windows installation*. For a fresh installation of Windows, you'll need to prepare a floppy disk that Windows setup will need while it is installing Vista or XP. On another computer, copy the RAID or non-RAID driver files from the card's driver CD to the disk. Read the card documentation to find out which folder on the CD contains these files. If your system does not have a floppy drive, most likely you can use a USB drive to hold the drivers.

  Then begin the Windows installation by booting the computer from the Windows setup CD or DVD. On the first screen of the Windows installation, a message appears at the bottom of the screen to select load driver (for Windows Vista) or press F6 (for Windows XP) to install storage drivers. Click **load driver** or press **F6**, insert the floppy disk, and follow the instructions on-screen to install the drivers. The Windows installation then proceeds normally.

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Figure 9-85 Use a hard drive dock to connect one or more internal hard drives to external ports on your computer
Courtesy of StarTech.com

- *Existing Windows installation uses the controller card*. To move the Windows hard drive from a motherboard connection to the storage controller card, first install the card under Windows. Then power down the system and move the SATA cable from the motherboard to the controller card. Restart the system.
- *Change the bootable hard drive to the controller card's drive*. Another situation is when you already have a Windows bootable hard drive installed that is using a motherboard connection and you want to use a second hard drive connected to the controller card as your boot device. For this situation, first install the controller card with the new drive attached. Then boot into BIOS setup and look for the option to **Boot SCSI first**. If BIOS setup has the option, enable it so that the system will boot to the drive connected to the controller card.

APPLYING CONCEPTS

Bill was hurriedly setting up a computer for a friend. When he got to the modem, he installed it as he had installed many modems in the past. He put the modem card in the PCI slot and turned on the PC for Plug and Play to do its job. When the Found New Hardware Wizard launched, he installed the drivers, but the modem wouldn't work. He tried again and again to reinstall the modem, but still it didn't work. After four hours of trying to get the modem to work, he concluded the modem was bad. Then it hit him to read the instructions that came with the modem. He opened the booklet and in very large letters on the very first page it said, "The modem WILL NOT WORK if you install the card first and the software second." Bill took the card out and followed the instructions and within five minutes he was surfing the Net. Bill says that from that day forward he *always* reads *all* instructions first and leaves his ego at the door! And for all other impatient installers, know that most devices come with a Quick Start guide.

TROUBLESHOOTING I/O DEVICES

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Generally, when troubleshooting an I/O device, including adapter cards and devices plugged into motherboard ports, follow these steps:

1. For a new installation, suspect the device or drivers are not installed correctly, or the application software does not work. Start at the beginning of the installation and redo and recheck each step. Use Device Manager to uninstall the device. Then restart the system and install the drivers again, this time looking carefully for error messages.
2. For adapter cards, verify the card is securely seated in the slot. Try a different slot. Does the card need a power cord that is not connected to it?
3. For problems after an installation, ask the user what has just changed in the system. For example, if there has been a recent thunderstorm, the device might have been damaged by electricity. Maybe the user has just installed some software or changed Windows settings.
4. Analyze the situation and try to isolate the problem. For example, decide if the problem is most likely caused by hardware or software.
5. Check simple things first. Is the device getting power? Is it turned on? Is the data connection secure? Try rebooting the system to get a fresh start.
6. Exchange the device for a known good one or install the suspected device in a working system.
7. Sources that you can use to help you understand an error message or a symptom include the Internet (manufacturer Web site or a general search), device documentation, training materials, technical support from the device manufacturer (by chat, phone, forums, and blogs), and technical people in your organization.
8. After the problem is fixed, document the symptoms, the source of the problem, and the solution so you have that to take into the next troubleshooting situation.

Let's now look at specific instructions for troubleshooting I/O ports, a keyboard, a monitor and video card, and other adapter cards.

TROUBLESHOOTING MOTHERBOARD I/O PORTS

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When you are having a problem with an I/O port on the motherboard, do the following:

1. Verify the problem is not with the device using the port. Try moving the device to another port on the same computer or move the device to another computer. If it works there, return it to this port. The problem might have been a bad connection.
2. Go into BIOS setup and verify the port is enabled.
3. Check Device Manager and verify Windows recognizes the port with no errors.
4. Uninstall and reinstall the drivers for the device using the port.
5. Update the motherboard drivers. You might be able to download drivers for this type port from the motherboard manufacturer Web site.
6. If you have a loop-back plug, use it to test the port. A **loop-back plug** is a tool used to test a serial, parallel, USB, network, or other port. To use one to test a port, you plug

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in the loop-back plug and then run the software that comes with the plug to test the port. Figure 9-86 shows loop-back plugs that come with CheckIt diagnostic software from SmithMicro Software (*www.smithmicro.com*).

Figure 9-86 Loop-back plugs used to test serial and parallel ports
Courtesy of Smith Micro Software, Inc.

7. If the problem is still not solved, disable the port in BIOS setup and install an I/O controller card to provide the same type port.

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TROUBLESHOOTING KEYBOARDS

Keyboards can give problems if they are not kept clean. If dirt, food, or drink is allowed to build up, one or more keys might stick or not work properly. Chips inside the keyboard can fail, and the keyboard cable or port connector can go bad. Because of its low cost, when a keyboard doesn't work, the solution is most often to replace it. However, you can try a few simple things to repair one, as listed next:

1. If a few keys don't work, turn the keyboard upside down and bump it to dislodge debris and use compressed air to blow out debris.
2. If the keyboard does not work at all, check to see if the cable is plugged in. Maybe it's plugged into the mouse port by mistake. Next, swap it with a known good keyboard.
3. If a PS/2 keyboard does not work, try a USB keyboard. The PS/2 port might be bad. Know that some motherboards have a jumper that must be set for a PS/2 or USB keyboard. For other motherboards, the option to use a USB keyboard must be enabled in BIOS setup. And for still other motherboards, you can install a USB keyboard without changing any jumpers or BIOS settings.

Notes Older computers refused to boot unless a keyboard was present. However, newer computers allow you to boot without a keyboard, and you can then plug in the keyboard after the boot.

4. If coffee or sugary drinks are spilled on the keyboard, the best solution is to simply replace the keyboard. You can try to save the keyboard by thoroughly rinsing it in running water, perhaps from a bathroom shower. Make sure the keyboard dries thoroughly before you

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use it. Let it dry for two days on its own, or fewer if you set it out in the sun or in front of a fan. In some situations, such as a factory setting where dust and dirt are everywhere, consider using a clear plastic keyboard cover.

TROUBLESHOOTING MONITORS AND VIDEO CARDS

For monitors as well as other devices, if you have problems, try doing the easy things first. For instance, try to make simple hardware and software adjustments. Many monitor problems are caused by poor cable connections or bad contrast/brightness adjustments.

Tip A user very much appreciates a PC support technician who takes a little extra time to clean a system being serviced. When servicing a monitor, take the time to clean the screen with a soft dry cloth or monitor wipe.

Typical monitor and video card problems and how to troubleshoot them are described next.

POWER LIGHT (LED) DOES NOT GO ON; NO PICTURE

For this problem, try the following:

- Is the monitor plugged in? Verify that the wall outlet works by plugging in a lamp, radio, or similar device. Is the monitor turned on? Look for a cutoff switch on the front and on the back. Some monitors have both.
- If the monitor power cord is plugged into a power strip or surge protector, verify that the power strip is turned on and working and that the monitor is also turned on.
- If the monitor power cord is plugged into the back of the computer, verify that the connection is tight and the computer is turned on.
- A blown fuse could be the problem. Some monitors have a fuse that is visible from the back of the monitor. It looks like a black knob that you can remove (no need to go inside the monitor cover). Remove the fuse and look for the broken wire indicating a bad fuse.
- The monitor might have a switch on the back for choosing between 110 volts and 220 volts. Check that the switch is in the right position.
- The problem might be with the video card. If you have just installed the card and the motherboard has onboard video, go into BIOS setup and disable the video port on the motherboard.
- Verify that the video cable is connected to the video port on the video card and not to a disabled onboard video port.

Caution A monitor retains a charge even after the power cord is unplugged. If you are trained to open a monitor case to replace a fuse, unplug the monitor and wait at least 60 minutes before opening the case so that capacitors have completely discharged.

Notes When you turn on your PC, the first thing you see on the screen is the firmware on the video card identifying itself. You can use this information to search the Web, especially the manufacturer's Web site, for troubleshooting information about the card.

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If none of these solutions solves the problem, the next step is to take the monitor to a service center.

POWER LED IS ON, NO PICTURE ON POWER-UP

For this problem, try the following:

- Check the contrast adjustment. If there's no change, leave it at a middle setting.
- Check the brightness or backlight adjustment. If there's no change, leave it at a middle setting.
- Make sure the cable is connected securely to the computer.
- If the monitor-to-computer cable detaches from the monitor, exchange it for a cable you know is good, or check the cable for continuity.
- If this solves the problem, reattach the old cable to verify that the problem was not simply a bad connection.
- Test a monitor you know is good on the computer you suspect to be bad. If you think the monitor is bad, make sure that it also fails to work on a good computer.
- If the monitor works while the system boots up, but the screen goes blank when Windows starts to load, the problem is more likely to be with Windows than with the monitor or video card. Try booting Windows in Safe Mode, which you will learn to do later in the chapter. Safe Mode allows the OS to select a generic display driver and low resolution. If this works, change the driver and resolution.
- Reseat the video card. For a PCI card, move the card to a different expansion slot. Clean the card's edge connectors, using a contact cleaner purchased from a computer supply store.
- If there are socketed chips on the video card, remove the card from the expansion slot and then use a screwdriver to press down firmly on each corner of each socketed chip on the card. Chips sometimes loosen because of temperature changes; this condition is called **chip creep**.
- Trade a good video card for the video card you suspect is bad. Test the video card you think is bad on a computer that works. Test a video card you know is good on the computer that you suspect is bad. Whenever possible, do both.
- Go into BIOS setup and disable the shadowing of video ROM.
- Test the RAM on the motherboard with diagnostic software.
- For a motherboard that is using an AGP or a PCI-Express video card, try using a PCI video card in a PCI slot.
- Trade the motherboard for one you know is good. Sometimes, though rarely, a peripheral chip on the motherboard can cause the problem.
- For notebook computers, is the LCD switch turned on? Function keys are sometimes used for this purpose.
- For notebook computers, try connecting a second monitor to the notebook and use the function key to toggle between the LCD panel and the second monitor. If the second monitor works, but the LCD panel does not work, the problem might be with the LCD panel hardware. How to solve problems with notebook computers is covered in Chapter 21.

POWER IS ON, BUT MONITOR DISPLAYS THE WRONG CHARACTERS

For this problem, try the following:

- Wrong characters are usually not the result of a bad monitor but of a problem with the video card. Trade the video card for one you know is good.
- Exchange the motherboard. Sometimes a bad ROM or RAM chip on the motherboard displays the wrong characters on the monitor.

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MONITOR FLICKERS, HAS WAVY LINES, OR BOTH

For this problem, try the following:

- Monitor flicker can be caused by poor cable connections. Check that the cable connections are snug.
- Does the monitor have a degauss button to eliminate accumulated or stray magnetic fields? If so, press it.
- Check if something in the office is causing a high amount of electrical noise (EMI). For example, you might be able to stop a flicker by moving the office fan to a different outlet. Bad fluorescent lights or large speakers can also produce interference. Two monitors placed very close together can also cause problems.
- If the refresh rate is below 60 Hz, a screen flicker might appear. Change the refresh rate to the highest value the monitor supports.
- For older monitors that do not support a high enough refresh rate, your only cure might be to purchase a new monitor. Before making a purchase, verify that the new monitor will solve the problem.

NO GRAPHICS DISPLAY OR THE SCREEN GOES BLANK WHEN LOADING CERTAIN PROGRAMS

For this problem, try the following:

- A special graphics or video accelerator card is not present or is defective.
- Video card drivers need updating. Use Device Manager to update the drivers.
- Updating Windows can sometimes solve video problems. How to update Windows is covered in Chapter 12.
- The video card does not support the resolution and/or color setting.
- There might not be enough video RAM. An older video card might have empty sockets on the card to hold additional video memory. See the card documentation to find out if additional video memory can be added.
- A virus is disrupting normal Windows operations. Scan the system for viruses using an updated version of antivirus software. How to solve problems with viruses is covered in Chapter 20.

SCREEN GOES BLANK 30 SECONDS OR ONE MINUTE AFTER THE KEYBOARD IS LEFT UNTOUCHED

A Green motherboard (one that follows energy-saving standards) used with an Energy Saver monitor can be configured to go into standby or sleep mode after a period of inactivity. This might be the case if the monitor resumes after you press a key or move the mouse. Video might be set to turn off display after a period set as short as 20 seconds to as long as one hour. The power LED normally changes from green to orange to indicate sleep mode. How to set sleep modes in Windows is covered in Chapter 21.

Notes Problems might occur if the motherboard power-saving features are turning off the monitor, and Windows screen saver is also turning off the monitor. If the system hangs when you try to get the monitor going again, try disabling one or the other. If this doesn't work, disable both.

You might be able to change the doze features by entering BIOS setup and looking for an option such as Power Management. In addition, note that some monitors have a Power Save switch on the back. Make sure this is set as you want.

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The screen saver feature of Windows can also set the monitor to turn off after so many minutes of inactivity. For Vista, right-click the desktop and select **Personalize** from the shortcut menu. In the Personalization window, click **Screen Saver**. Set the minutes in the Screen Saver Settings box. For XP, the number of minutes is set in the Display Properties window. Open Control Panel, select **Display**, and then select **Screen Saver**.

POOR COLOR DISPLAY

For this problem, try the following:

- Read the monitor documentation to learn how to use the color-adjusting buttons to fine-tune the color.
- Exchange video cards.
- Your video card might allow you to install additional video RAM. See the card's documentation.
- Check if a fan, a large speaker (speakers have large magnets), or a nearby monitor could be causing interference.
- If a CRT monitor displays blue and green, but no red, then the red electron gun might be bad. Replace the monitor. Same for missing blue or green colors.
- Odd-colored blotches on the screen might indicate a device such as a speaker or fan is sitting too close to the monitor and emitting EMI. Move any suspected device away from the monitor.

PICTURE OUT OF FOCUS OR OUT OF ADJUSTMENT

For this problem, try the following:

- Change the resolution of an LCD monitor to its native resolution. If the highest resolution seems stretched or fuzzy, it is likely the video card or monitor manufacturer drivers have not been installed and this highest resolution is not the monitor's native resolution. Download the latest drivers for your OS from the video card manufacturer Web site and install them. Also install the latest drivers for your OS from the Web site of the monitor manufacturer.
- Using the display utility from the video card manufacturer, try different adjustments and settings to see if you can discover the best settings for your monitor. To access the utility, look for it listed in the shortcut menu when you right-click the Windows desktop.
- Check the adjustment knobs on the control panel on the outside of the monitor.
- Change the refresh rate. Sometimes this can make the picture appear more focused.
- You can also make adjustments inside the monitor that might solve the problem. If you have not been trained to work inside the monitor, take it to a service center.

Notes For LCD monitors and Windows XP, you can improve how fonts are displayed on the screen. On the Display Properties window, click the **Appearance** tab and then click **Effects**. The Effects dialog box appears (see Figure 9-87). Check **Use the following method to smooth edges of screen fonts**. Then, from the drop-down list, select **ClearType**. Click **OK** twice to close both windows.

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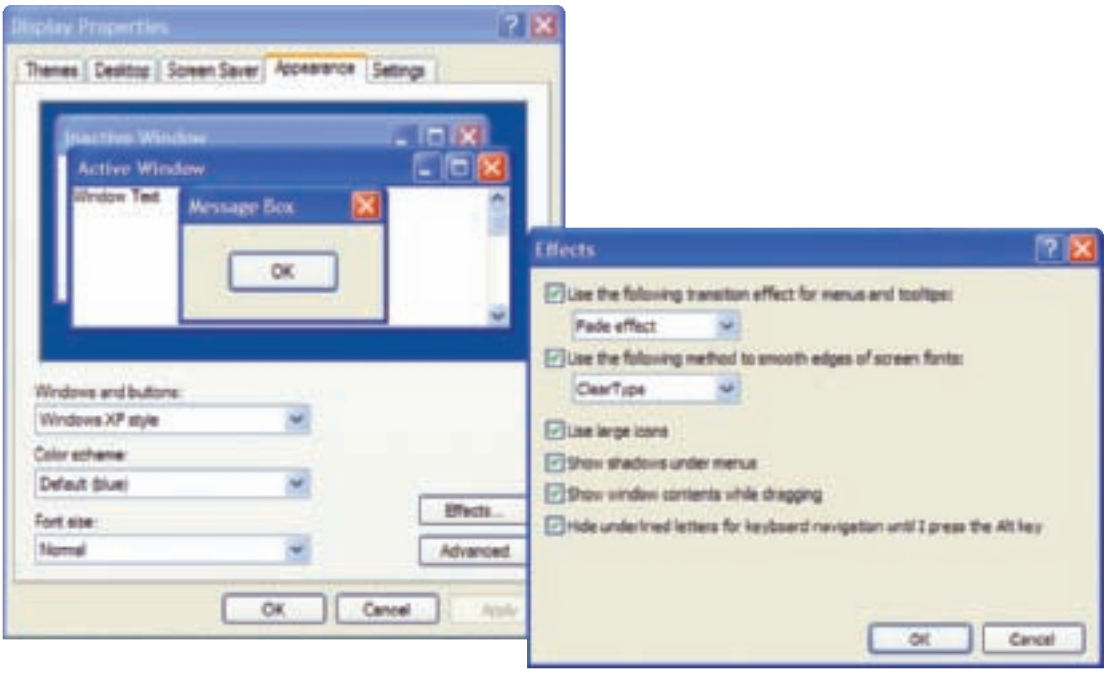

Figure 9-87 Use the Effects dialog box to improve displayed fonts using an LCD monitor
Courtesy: Course Technology/Cengage Learning

CRT MONITOR MAKES A CRACKLING SOUND

Dirt or dust inside the unit might be the cause. Someone at a computer monitor service center trained to work on the inside of the monitor can vacuum inside it. Recall from Chapter 4 that a monitor holds a dangerous charge of electricity, and you should not open one unless trained to do so.

Tip For laptops, you can adjust the brightness of the display using function keys. See your notebook user manual to find out how.

DISPLAY SETTINGS MAKE THE SCREEN UNREADABLE

When the display settings don't work, you can easily return to standard VGA settings, which include a resolution of 640 x 480. Do the following:

- Reboot the system and press the **F8** key after the first beep. The Advanced Boot Options menu appears. Figure 9-88 shows the Vista menu; the XP menu is similar.
- Select **Safe Mode** to boot up with minimal configurations and standard VGA display mode. For Windows XP, you can also try **Enable VGA Mode** from the Advanced Options menu. And for Vista, you can try **Enable low-resolution video (640 x 480)**.
- Use the Vista Display Settings box or the XP Display Properties box to correct the video settings.

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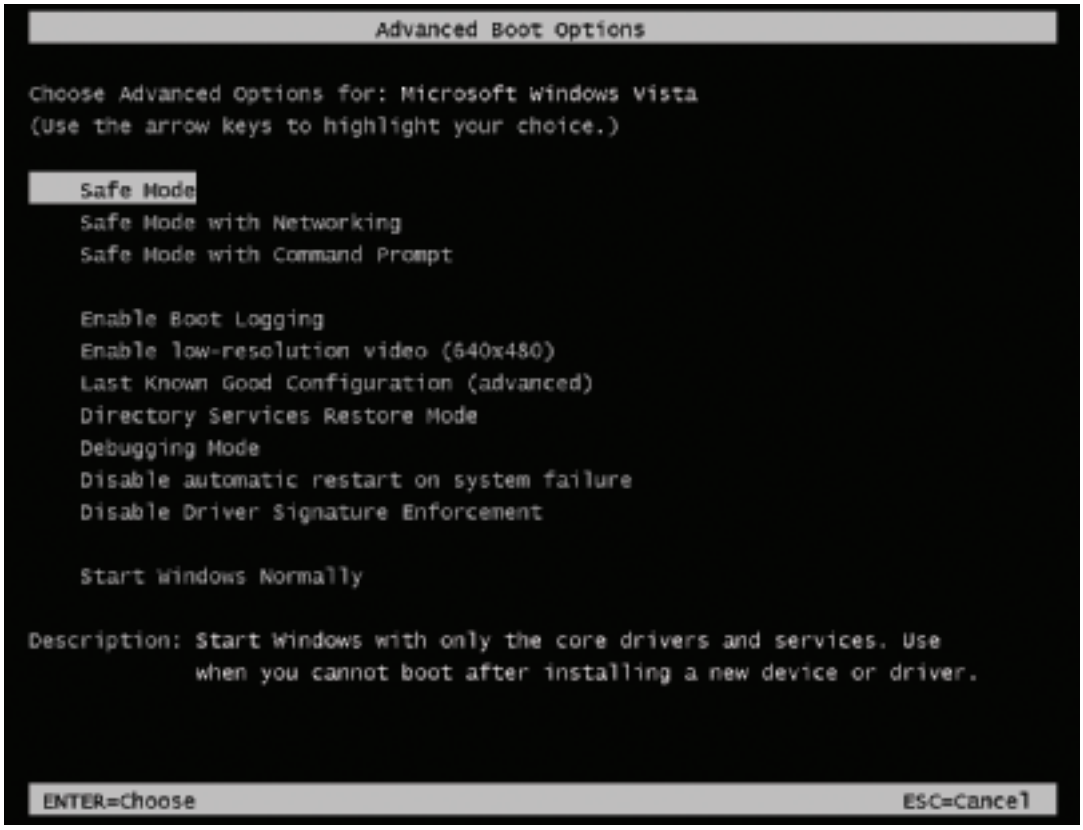

Figure 9-88 Press F8 to see the Advanced Boot Options menu
Courtesy: Course Technology/Cengage Learning

Caution A CRT monitor screen is made of leaded glass, and a monitor contains capacitors that can hold a charge even after the monitor is unplugged. Therefore, it's important to dispose of a monitor correctly. For capacitors to fully discharge, it is not safe to remove the cover of a monitor until it has remained unplugged for at least one hour. To know how to dispose of a monitor, check with local county or environment officials for laws and regulations that apply to your area.

TROUBLESHOOTING OTHER ADAPTER CARDS

For adapter cards other then the video card, follow these steps:

1. Make sure the device connected to the card is working. For example, if an external CD drive is using an eSATA port on a storage controller card, move the drive to another eSATA port. If the drive works on that port, return it to the controller card. Perhaps a bad connection was the problem.
2. Update the driver drivers for the card. Download the latest drivers from the manufacturer Web site. Also, use the process described in Chapter 12 to make sure all Windows updates are current.
3. Try uninstalling the card. Use Device Manager to uninstall the card drivers. An exception to this might be a storage controller card. Its drivers might need to be uninstalled by executing the Setup.exe program on the driver CD. For example, when you run this program for one card, the window in Figure 9-89 appears. Select **Remove** and click **Next** to uninstall the drivers.

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Figure 9-89 Use the Setup program on CD to uninstall the adapter card drivers
Courtesy: Course Technology/Cengage Learning

4. Then reboot the system and install the drivers again. Watch for error messages during the installation.
5. Try reseating the card or moving it to a different slot.
6. Search for diagnostic software on the driver CD or on the manufacturer Web site.
7. Use technical resources available on the manufacturer Web site for things to do and try.
8. Search the Internet for error messages and problems and solutions with the card.
9. Try replacing the card with one you know is good.

>> CHAPTER SUMMARY

- Adding new devices to a computer requires installing hardware and software. Even if you know how to generally install an I/O device, always follow the specific instructions of the product manufacturer.
- Use Device Manager under Windows to manage hardware devices.
- I/O ports on a motherboard include eSATA, FireWire, USB, parallel, serial, and PS/2 ports.
- USB ports can run at SuperSpeed USB (up to 5.0 Gbps), Hi-Speed USB (480 Mbps), or Original USB (1.5 Mbps or 12 Mbps) with up to 127 USB devices daisy chained together.
- Two popular versions of FireWire are FireWire 800 (800 Mbps) and FireWire 400 (400 Mbps).
- Serial ports use a DB9 or DB25 connector.

- Parallel ports can support EPP or ECP. ECP is faster and requires a DMA channel.
- Technologies and features of CRT and LCD monitors include screen size, refresh rate, interlacing (for CRT), response time (for LCD), pixel pitch, resolution, native resolution (for LCD), color quality, multiscan (for CRT), contrast ratio, and viewing angle (for LCD). In addition, consider the type connectors that a monitor uses. Most common types are VGA and DVI.
- Ports on a video card might include a 15-pin VGA port, one or more DVI-I or DVI-D ports, composite video port, S-Video port, and HDMI port.
- To use the Aero user interface, Vista requires a video card or onboard video to have at least 128 MB of video RAM, support DirectX version 9, and use the Windows Display Driver Model (WDDM).
- The dxdiag.exe command is used to report information about hardware, including the video card and which version of DirectX it is using.
- A keyboard can use a DIN, PS/2, USB, or wireless connection. For most installations, all that is necessary is to plug in the keyboard and turn on the system.
- A touch screen is likely to use a USB port. Software is installed to calibrate the touch screen to the monitor screen and receive data input.
- Biometric input devices, such as a fingerprint reader, collect biological data and compare it to that recorded about the person to authenticate the person's access to a system.
- A KVM switch lets you use one keyboard, monitor, and mouse with multiple computers.
- Most likely an adapter card is physically installed in a system and when Windows starts up, it detects the card and then you install the drivers using the Windows wizard. However, always follow instructions from the device manufacturer when installing an adapter card because the order of installing the card and drivers might be different.
- When installing Windows on a hard drive that is controlled by a storage controller adapter card, the card drivers must be installed during the Windows installation. You are given an opportunity at the beginning of the Windows installation to provide the drivers on floppy disk or perhaps a USB device.

>> KEY TERMS

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

biometric device
chip creep
COM1 (Communications port 1)
CRT (cathode-ray tube)
degauss button
DVI-D
DVI-I
dxdiag.exe
ECP (Extended Capabilities Port)
Energy Star
EPP (Enhanced Parallel Port)
FireWire
flat panel monitors
hard drive dock
HDMI (High-Definition Multimedia Interface)
hub
i.Link
I/O controller card
IEEE 1284
IEEE 1394
IEEE 1394.3
infrared transceiver
interlaced
IR transceiver
IrDA (Infrared Data Association) transceiver
IRQ (Interrupt ReQuest) line
isochronous data transfer
KVM (Keyboard, Video, and Mouse) switch
LCD (Liquid Crystal Display) monitor
LPT (Line Printer Terminal)
native resolution
noninterlaced
refresh rate
resolution
RGB (red, green, and blue)
RS-232c (Reference Standard 232 revision c or Recommended Standard 232 revision c)
standard parallel port (SPP)
Super VGA (SVGA)
S-Video port
touch screen
UART (Universal Asynchronous Receiver-Transmitter)
VGA (Video Graphics Adapter)

>> REVIEWING THE BASICS

1. Which is faster, an eSATA port or a FireWire 800 port?
2. What is the speed for Hi-Speed USB?
3. How many times faster is a Hi-Speed USB port than an Original USB port running at 12 Mbps?
4. How many times faster is a FireWire 800 port than a FireWire 400 port?
5. Which USB port is square and which USB port is flat and wide?
6. Does Windows XP without any service packs applied support Hi-Speed USB?
7. How many pins does a FireWire 800 port have?
8. Which parallel port standard uses a DMA channel?
9. How many pins does the most common type of serial port have?
10. What type of wireless transmission requires a line-of-sight clearance?
11. Which is better for your eyes, a monitor that supports 75 Hz refresh rate or one that supports 60 Hz refresh rate?
12. For an LCD monitor, what is the best resolution to use?
13. Which type port gives the best output, a composite out port or an S-Video port?
14. What command do you use to find out what version of DirectX your video card is using?
15. Name three types of ports a keyboard might use.
16. What two types of ports might a touch screen use?
17. Which Windows utility is most likely the one to use when uninstalling an expansion card?
18. Would you expect all the devices listed in BIOS setup to also be listed in Device Manager? Would you expect all devices listed in Device Manager to also be listed in BIOS setup?
19. If ECP mode does not work on your parallel port, what should you do next?
20. Why is it best to leave a slot empty between two expansion cards?
21. What two technologies allow you to use more than one video card in a system?
22. If you are installing Windows on a hard drive that is managed by a RAID storage controller card, when and how do you install the RAID drivers?
23. If a monitor displays wrong characters, which device is likely to be the problem?
24. What is the display resolution for standard VGA settings?
25. What key do you press at startup to display the Vista Advanced Boot Options window?

>> THINKING CRITICALLY

1. If a PS/2 keyboard does not work on your system and yet you know the keyboard is good, what is the best solution?
   a. Disable the PS/2 port in BIOS setup and use a PS/2 splitter to install a keyboard and mouse using the PS/2 mouse port.

b. Install a USB keyboard on a USB port.

c. Exchange the PS/2 port on your motherboard.

d. Replace the motherboard.

2. You plug a new scanner into a USB port on your Windows XP system. When you first turn on the scanner, what should you expect to see?

a. A message displayed by the scanner software telling you to reboot your system.

b. You see the Found New Hardware Wizard launch.

c. Your system automatically reboots.

d. An error message from the USB controller.

3. You install the software bundled with your digital camera to download pictures from your camera to your system using a serial port. Next, you plug up the camera to the port using a serial cable and turn on your camera. You attempt to use the software to download pictures, but the software does not recognize the camera is present. What do you do next?

a. Return the camera and purchase one that uses a USB port for downloading.

b. Reinstall the bundled software.

c. Access BIOS setup and verify that the serial port is enabled.

d. Use Device Manager to verify that the OS recognizes the serial port.

e. Replace the serial cable.

4. You turn on your Windows Vista computer and see the system display POST messages. Then the screen turns blue with no text. Which of the following items could be the source of the problem?

a. The video card

b. The monitor

c. Windows

d. MS Word software installed on the system

>> HANDS-ON PROJECTS

PROJECT 9-1: Installing a Device

Install a device on a computer. If you are working in a classroom environment, you can simulate an installation by moving a device from one computer to another. Devices that you might consider installing are a video card, Web camera, I/O controller card, CD drive, or fingerprint reader.

PROJECT 9-2: Researching a Computer Ad

Pick a current Web site or magazine ad for a complete, working computer system, including computer, monitor, keyboard, and software, together with extra devices such as a mouse or printer. Research the details of the ad and write a two- to four-page report describing and explaining these details. This project provides a good opportunity to learn about the latest offerings on the market as well as current pricing.

PROJECT 9-3: Comparing Two Computer Ads

Find two ads for computer systems containing the same processor. Compare the two ads. Include in your comparison the different features offered and the weaknesses and strengths of each system.

PROJECT 9-4: Searching the Internet for a Video Driver

You are about to upgrade your PC from Windows XP to 32-bit Windows Vista. Before performing the upgrade, search the Internet for a new video driver for your Matrox G450x4 MMS graphics card. What is the name of the file you need to download from the Matrox Web site for the upgrade?

PROJECT 9-5: Preparing for Windows Vista

Microsoft says that to get the best video experience from Windows Vista, your graphics card must qualify for the OS. Do the following to find out if your system qualifies:

1. Find out what graphics card is installed on your computer. What card is installed and how did you find out?
2. Search the Microsoft Web site (*www.windowsmarketplace.com*) for your card. If your card qualifies, print the Web page that shows your card qualifies for Vista.
3. If your card does not qualify, print the Web page of another video card that will work in your computer and that does qualify for Vista. How much does the upgrade card cost?

PROJECT 9-6: Working with a Monitor

Do the following to practice changing monitor settings and troubleshooting monitor problems:

1. Using a Windows OS, list the steps to change the monitor resolution.
2. Using Windows Vista or Windows XP, practice changing the display settings, including the wallpaper, screen saver, and appearance. If you are not using your own computer, be sure to restore each setting after making changes.
3. Pretend you have made a mistake and selected a combination of foreground and background colors that makes reading the screen impossible. Solve the problem by booting Windows into Safe Mode. Correct the problem and then reboot.
4. Change the monitor resolution using the sliding bar in the Display Settings or Display Properties box. Make a change and then make the change permanent. You can go back and adjust it later if you want.
5. Work with a partner who is using a different computer. Unplug the monitor in the computer lab or classroom, loosen or disconnect the computer monitor cable, or turn the contrast and brightness all the way down, while your partner does something similar to the other PC. Trade PCs and troubleshoot the problems.
6. Wear a ground bracelet. Turn off the PC, press the power button, remove the case cover, and loosen the video card. Turn on the PC and write down the problem as a user would describe it. Turn off the PC, reseat the card, and verify that everything works.

7. Turn off your system. Insert into the system a defective video card provided by your instructor. Turn on the system. Describe the resulting problem in writing, as a user would.

>> REAL PROBLEMS, REAL SOLUTIONS

REAL PROBLEM 9-1: Helping with Upgrade Decisions

Upgrading an existing system can sometimes be a wise thing to do, but sometimes the upgrade costs more than the system is worth. Also, if existing components are old, they might not be compatible with components you want to use for the upgrade. A friend, Renata, asks your advice about several upgrades she is considering. Answer these questions:

1. Renata has a Windows XP PC that does not have a FireWire port. She wants to use a camcorder that has a FireWire 400 interface to a PC. How would she perform the upgrade and what is the cost? Print Web pages to support your answers.
2. Her computer has one USB port, but she wants to use her USB printer at the same time she uses her USB scanner. How can she do this and how much will it cost? Print Web pages to support your answers.
3. Renata also uses her Windows XP computer for gaming. The computer has an AGP 2.0 1.5-V video slot and three PCI slots. What is the fastest and best graphics card she can buy? How much does it cost? Print Web pages to support your answer.
4. What is the total cost of all the upgrades that Renata wants? Do you think it is wise for her to make these upgrades or purchase a new system? How would you explain your recommendation to her?

REAL PROBLEM 9-2: Using Input Director

Input Director is software that lets you use one keyboard and mouse to control two or more computers that are networked together. You can download the free software from *www.inputdirector.com*. To use the software, you need to know the host name of each computer that will share the keyboard and mouse. To find out the host name, right-click **Computer** (**My Computer** in Windows XP) and select **Properties**. The host name is listed in Vista as the Computer name and in XP as Full computer name.

Working with a partner, download and install Input Director and configure it so that you and your partner's computers are using the same keyboard and mouse.