

6-1 Basic Principles for Supporting I/O Devices

Core 1 Objective

- 3.1

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

An I/O or storage device can be either internal (installed inside the computer case) or external (installed outside the case and called a peripheral device). These basic principles apply to supporting both internal and external devices:

- **Every device is controlled by software.** When you install a new device, such as a webcam, you must install both the device and the device drivers to control it. These device drivers must be written for the OS (operating system) you are using. Recall from earlier modules that the exceptions to this principle are some simple devices, such as the keyboard, which are controlled by the system BIOS/UEFI. Also, Windows has embedded device drivers for many devices. For example, when you install a video card, Windows can use its embedded drivers to communicate with the card, but to use all the features of the card, you can install the drivers that came bundled with it or download the drivers from the manufacturer's website.
- **When it comes to installing or supporting a device, the manufacturer knows best.** In this module, you 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's documentation, and follow those guidelines first. For example, for most installations, you install the device before you install the device drivers. However, for some devices, such as a wireless keyboard, you might need to install the device drivers 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 capture card and its device drivers, you might also need to install the Wondershare Demo Creator software to use the capture card.
- **A device is no faster than the port or slot it is designed to use.** When buying a new external device, pay attention to the type of port for which it is rated. For example, an external hard drive designed to use a USB 2.0 port will work using a USB 3.0 port, but it will work at the USB 2.0 speed even when it's connected to the faster USB 3.0 port. As another example, a video card in a PCI slot will not work as fast as a

video card in a PCI Express slot because of the different speeds of the slots.

- **Use an administrator account in Windows.** When installing hardware devices under Windows, you need to be signed in to the system with a user account that has the highest level of privileges to change the system. This type of account is called an administrator account.
- **Problems with a device can sometimes be solved by updating the device drivers.** Device manufacturers often release updates to device drivers. Update the drivers to solve problems with the device or to add new features. You can use Device Manager in Windows to manage devices and their drivers.
- **Install only one device at a time.** If you have several devices to install, install one and restart the system. Make sure that device is working and that all is well with the system before you move on to install another device.

Recall that **Device Manager** (its program file is named `devmgmt.msc`) is your primary Windows tool for managing hardware. It lists almost all installed hardware devices and the drivers they use. (Printers and many USB devices are not listed in Device Manager.) 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).

Before we move on to installing devices, you need to be familiar with the ports on a computer. When selecting a new device, you can get the best performance by selecting one that uses the fastest wired or wireless connection standard available on your computer.

6-1a Wired and Wireless Connection Standards Used by Peripheral Devices

Core 1 Objective

- 3.1

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

When deciding which connection standard to use for a new device, the speed of the transmission standard is often a tiebreaker. [Table 6-1](#) shows the speeds of various wired and wireless standards, from fastest to slowest. This table can help you decide whether speed should affect your purchasing decisions—for example, when you are deciding between a USB 2.0 printer

connection and a Bluetooth wireless connection. Standards for video transmissions are not included in this table.

Table 6-1

Data Transmission Speeds for Various Wired and Wireless Connections

Port or Wireless Type	Maximum Speed	Maximum Cable Length or Wireless Range
Thunderbolt 4	40 Gbps	Copper cables up to 2 meters; compatible with a USB connector
USB4	40 Gbps	Cable lengths up to 1 meter
Thunderbolt 3	40 Gbps	Copper cables up to 2 meters; compatible with a USB connector
Thunderbolt 2	20 Gbps	Copper cables up to 100 meters
SuperSpeed+ USB (USB 3.2)	20 Gbps	For maximum speed, cable length up to 1 meter; requires USB-C connector
SuperSpeed+ USB (USB 3.1)	10 Gbps	Cable lengths up to 3 meters
Wi-Fi 802.11ax (WiFi 6) RF (radio frequency) of 2.4 GHz or 5.0 GHz	9.6 Gbps	Undetermined
eSATA Version 3 (eSATA-600)	6.0 Gbps	Cable lengths up to 2 meters
SuperSpeed USB (USB 3.0)	5.0 Gbps	Cable lengths up to 3 meters
eSATA Version 2 (eSATA-300)	3.0 Gbps	Cable lengths up to 2 meters
eSATA Version 1 (eSATA-150)	1.5 Gbps or 1500 Mbps (megabits per second)	Cable lengths up to 2 meters
Wi-Fi 802.11ac (WiFi 5) RF of 5.0 GHz	3.5 Gbps	Range up to 50 meters
Wi-Fi 802.11n RF of 2.4 GHz or 5.0 GHz	Up to 600 Mbps	Range up to 70 meters
Lightning	480 Mbps	Cable lengths up to 2 meters
Hi-Speed USB (USB 2.0)	480 Mbps	Cable lengths up to 5 meters
Wi-Fi 802.11g RF of 2.4 GHz	Up to 54 Mbps	Range up to 100 meters
Wi-Fi 802.11a	Up to 54 Mbps	Range up to 50 meters

Port or Wireless Type	Maximum Speed	Maximum Cable Length or Wireless Range
RF of 5.0 GHz		
Wi-Fi 802.11b RF of 2.4 GHz	Up to 11 Mbps	Range up to 100 meters
Bluetooth wireless RF of 2.45 GHz	Up to 3 Mbps	Range up to 10 meters
Near Field Communication (NFC) RF of 13.56 MHz	Up to 424 kbps	Range up to 4 centimeters



Exam Tip

The A+ Core 1 exam expects you to be able to decide the best connection type given a scenario. Some of the facts you need to know are found in [Table 6-1](#).

6-1b Connectors and Ports Used by Peripheral Devices

Core 1 Objective

• 3.1

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

Take a look at the back of a computer, and you're likely to see a group of ports, several of which you saw in [Table 1-1](#) in the module "[Taking a Computer Apart and Putting It Back Together](#)." In this section of the module, we survey ports used by a variety of I/O devices and ports used for video, TV, and other specific uses. We begin our survey with USB.

USB Connections and Ports

Here is a summary of important facts you need to know about USB connections:

- The USB Implementers Forum, Inc. (usb.org), the organization responsible for developing USB, uses the symbols shown in [Figure 6-1](#) to indicate **USB4**, SuperSpeed+ USB (USB 3.2 and USB 3.1), SuperSpeed USB (**USB 3.0**), Hi-Speed USB (**USB 2.0**), or Original USB (USB 1.1).

Figure 6-1

USB4, SuperSpeed+, SuperSpeed, Hi-Speed, and Original USB logos appear on products certified by the USB Forum





Source: USB Forum

- 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.
- USB uses serial transmissions, and USB devices are **hot-swappable**, meaning that you can plug in or unplug one without first powering down the system.
- 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. Four general categories of USB ports and connectors are USB-C, regular USB, micro USB, and mini USB. **Mini USB** connectors are smaller and more durable than **micro USB**, which are smaller than regular USB connectors. USB4 only uses USB-C connectors. [Table 6-2](#) shows the different USB connectors on USB cables.

Table 6-2

USB Connectors

Cable and Connectors	Description
A-Male to B-Male cable 	The A-Male connector on the left is flat and wide and connects to an A-Male USB port on a computer or USB hub. The B-Male connector on the right is square and connects to a USB 1.x or 2.0 device such as a printer.
Mini-B to A-Male cable 	The Mini-B connector has five pins and is often used to connect small electronic devices to a computer.
A-Male to Micro-B cable	The Micro-B connector has five pins and has a smaller height than the Mini-B connector. It's used on tablets, cell phones, and other small electronic devices.

Cable and Connectors	Description
	
<p>A-Male to Micro-A cable</p> 	<p>The Micro-A connector has five pins and is smaller than the Mini-B connector. It's used on cell phones and other small electronic devices.</p>
<p>USB 3.0 A-Male to USB 3.0 B-Male cable</p> 	<p>This USB 3.0 B-Male connector is used by SuperSpeed USB 3.0 devices such as printers or scanners. Devices that have this connection can also use regular B-Male connectors, but this USB 3.0 B-Male connector will not fit the connection on a USB 1.1 or 2.0 device. USB 3.0 A-Male and B-Male connectors and ports are blue.</p>
<p>USB 3.0 A-Male to USB 3.0 Micro-B cable</p> 	<p>The USB 3.0 Micro-B connector is used by SuperSpeed USB 3.0 devices. The connectors are not compatible with regular Micro-B connectors.</p>
<p>USB 3.1 A-Male to USB-C 3.1 cable</p> 	<p>The USB-C connector (also called the USB Type-C connector) on the right is flat with rounded sides and connects to a USB-C port on a computer or device, such as the latest smartphones or a graphics tablet. USB-C connectors do not have a specific orientation and are backward compatible with USB 2.0 and USB 3.0. The connector is required to attain maximum speeds with USB 3.2 devices.</p>



Note 1

Sometimes a mouse that uses USB 2.0 gives problems when plugged into a USB 3.0 port. If a mouse refuses to work or is unstable, try moving it to a USB 2.0 port.

Note 2

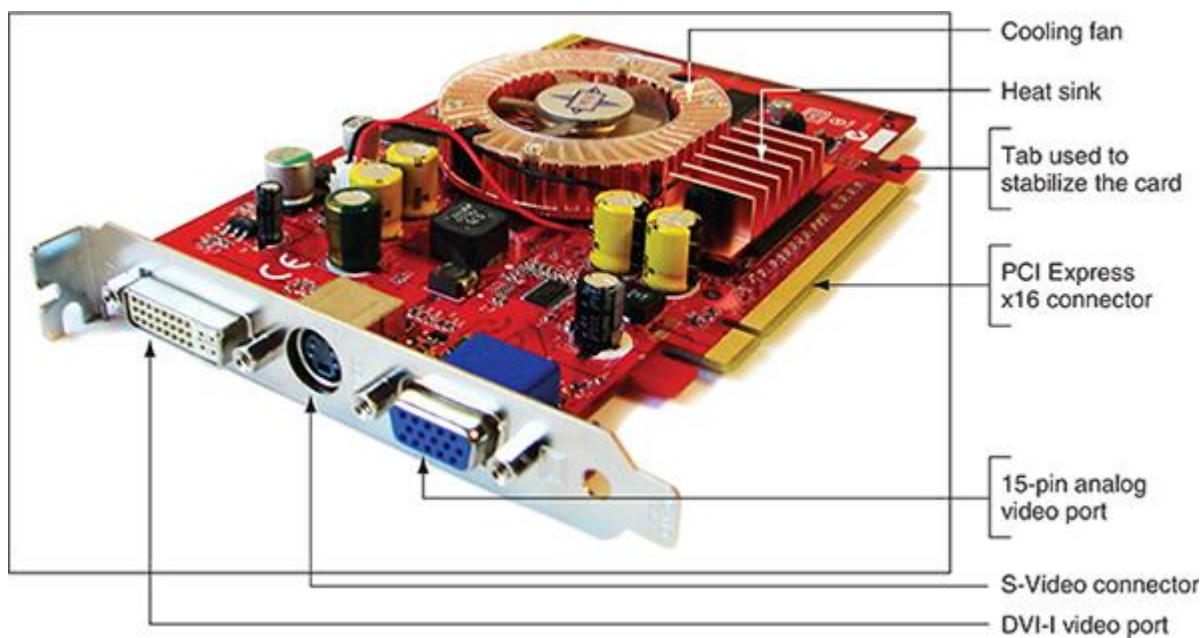
A USB 3.0 A-Male connector or port has additional pins compared with USB 1.1 or 2.0 ports and connectors, but it is still backward compatible with USB 1.1 and 2.0 devices. A USB 3.0 A-Male or B-Male connector or port is usually blue. Take a close look at the blue and black USB ports shown in [Figure 1-16](#) in the module “[Taking a Computer Apart and Putting It Back Together](#).”

Video Connectors and Ports

Video ports are provided by a video card or the motherboard. Video cards (see [Figure 6-2](#)) are sometimes called graphics adapters, graphics cards, or display cards. Most motherboards sold today have one or more video ports integrated into the motherboard and are called onboard ports. If you are buying a motherboard with a video port, make sure that you can disable the video port on the motherboard if it gives you trouble. You can then install a video card and use its video port rather than the port on the motherboard. Recall that a video card can use a PCI or PCI Express slot on the motherboard. The fastest slot to use is a PCIe $\times 16$ slot.

Figure 6-2

The PCX 5750 graphics card by MSI Computer Corporation uses the PCI Express $\times 16$ local bus



Recall that types of video ports include VGA, DVI, DisplayPort, and HDMI connectors. In addition to these ports, you also need to know about DVI-I and DVI-D ports. These ports are described here:

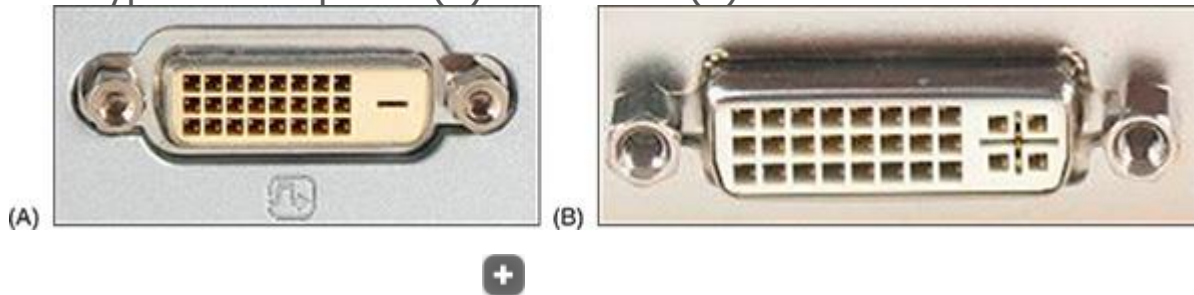
- **VGA.** The 15-pin VGA port is the standard analog video port and transmits three signals of red, green, and blue (RGB). A VGA port is sometimes called a DB-15 port.
- **DVI ports.** DVI ports were designed to replace VGA, and variations of DVI can transmit analog and/or digital data. The DVI standards specify the maximum length for DVI cables as 5 meters, although some video cards produce a strong enough signal to allow for longer DVI cables.

Here are the variations of DVI:

- **DVI-D.** The **DVI-D** port only transmits digital data. Using an adapter to convert a VGA cable to the port won't work. You can see a DVI-D port in [Figure 6-3A](#).

Figure 6-3

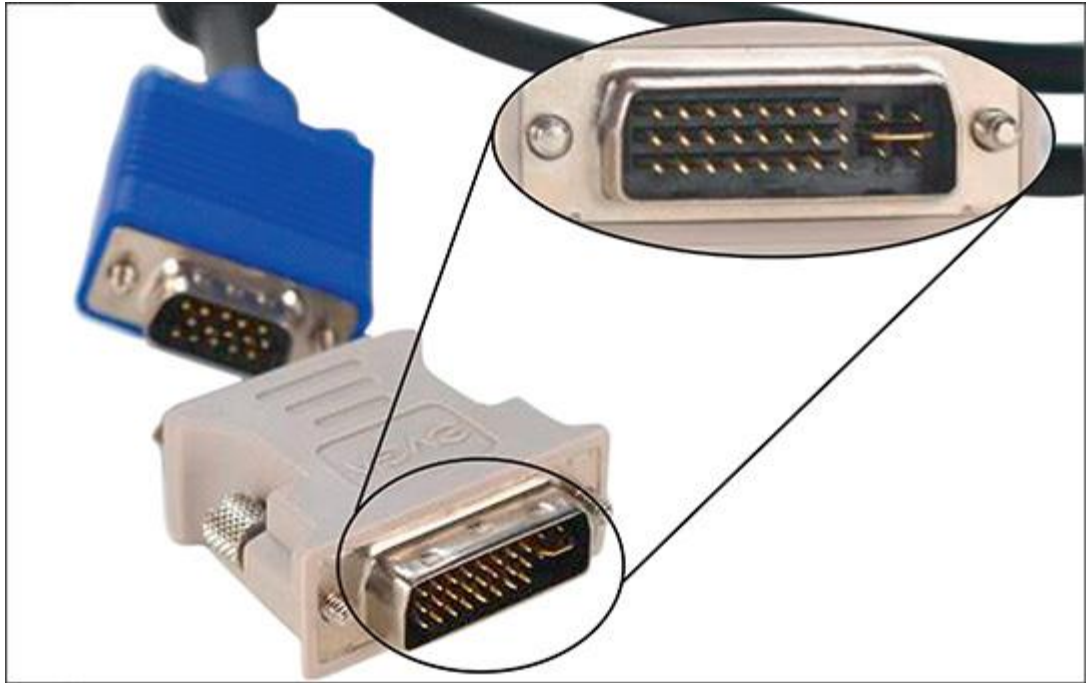
Two types of DVI ports: (A) DVI-D and (B) DVI-I



- **DVI-I.** The **DVI-I** port (see [Figure 6-3B](#)) supports both analog and digital signals. Analog data is transmitted using the extra four holes on the right side of the connector. If a computer has this type of port, you can use a digital-to-analog adapter to connect an older analog monitor to the port using a VGA cable (see [Figure 6-4](#)). If a video card has a DVI port, it most likely will be the DVI-I port (the one with the four extra holes) so you can use an adapter to convert the port to a VGA port.

Figure 6-4

A digital-to-analog video port converter using a DVI-I connector with four extra pins



- **DisplayPort.** DisplayPort was designed to replace DVI and can transmit digital video and audio data. It uses data packet transmissions similar to those of Ethernet, USB, and PCI Express and is expected to ultimately replace VGA, DVI, and HDMI on desktop and laptop computers. Besides the regular DisplayPort used on video cards and desktop computers, laptops might use the smaller **Mini DisplayPort**. [Figure 6-5](#) shows a DisplayPort to Mini DisplayPort cable. The maximum length for DisplayPort cables is 15 meters.

Figure 6-5

A DisplayPort to Mini DisplayPort cable



BIOS/UEFI setup can be used to manage onboard DisplayPort and HDMI ports. For example, [Figure 6-6](#) shows the BIOS screen where you can enable or disable the audio transmissions of DisplayPort and HDMI ports and still use these ports for video.

Figure 6-6

Use BIOS/UEFI setup to enable or disable onboard ports



Source: Intel

- **HDMI connectors.** HDMI transmits both digital video and audio, and it was designed to be used by home theater equipment. The HDMI standards allow for several types of HDMI connectors. The best known, which is used on most computers and televisions, is the Type A 19-pin **HDMI connector**. [Figure 6-7](#) shows a cable with HDMI and mini HDMI connectors, which is useful when connecting devices like a smartphone to a computer. [Figure 6-8](#) shows an HDMI to DVI-D cable. The maximum length of an HDMI cable depends on the quality of the cable; no maximum length has been specified.

Figure 6-7

An HDMI to mini-HDMI cable



Figure 6-8

An HDMI-to-DVI-D cable can be used to connect a computer that has a DVI port to home theater equipment that uses an HDMI port



Source: Courtesy of Belkin Corporation

Exam Tip

The A+ Core 1 exam expects you to know about these video connector types: HDMI, DisplayPort, DVI, and VGA. You must also be able to choose which connector type is the right solution given a scenario.

Additional Connectors and Ports

Besides USB and video, here are a few other ports and connectors you need to know about:

- **Thunderbolt.** **Thunderbolt** is a multipurpose connector used to connect high-end displays and external storage devices and to provide power for smartphones and laptops (see [Figure 6-9](#)). Earlier versions of Thunderbolt were limited to Apple products and used the DisplayPort base connection. The latest two versions, Thunderbolt 4 and Thunderbolt 3, use the USB-C connection (marked with a lightning bolt symbol), which opens the compatibility of Thunderbolt connections to non-Apple products. The USB-C Thunderbolt 4 and 3 ports can support data transfer rates up to 40 Gbps.

Figure 6-9

The Thunderbolt 3 cable uses the USB-C connector



Source: Apple Inc.

- **eSATA.** The eSATA port is used for connecting external storage devices to a computer (see [Figure 6-10](#)).

Figure 6-10

An eSATA connection is used to connect external storage devices to a computer



Source: [Amazon.com](https://www.amazon.com), Inc.

- **Lightning.** The **Lightning** connector is an Apple-specific connector for its mobile devices (see [Figure 6-11](#)). It is used to charge mobile devices, to transfer data, and to connect peripheral devices, such as a credit card payment device or headphone jack, to the Apple mobile device. The connector is reversible.

Figure 6-11

This Lightning-to-USB-C cable connects an Apple mobile device to a USB-C port



Source: Apple Inc.

- **RS-232.** USB or other connectors have replaced the serial **RS-232** connectors once used with mice, keyboards, dial-up modems, and peripheral connections. However, you might see a serial RS-232 connector on a rack server to set up a terminal to access the server. An earlier version of RS-232 had a 25-pin connector, but all RS-232 connectors today use nine pins and are often called DB-9 connectors (see [Figure 6-12](#)).

Figure 6-12

The serial DB-9 connector may be used to connect a terminal to a server installed in a rack



Source: Cablestogo.com

Now that you know about the connection standards, ports, and connectors for external devices, let's see how to install them.

6-2 Identifying and Installing I/O Peripheral Devices

Core 1 Objectives

- 1.1
Given a scenario, install and configure laptop hardware and components.
- 1.2
Compare and contrast the display components of mobile devices.
- 3.4
Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

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

Peripheral devices you might be called on to install include keyboards, mice, touch pads, touch screens, microphones, digitizers, webcams, and display devices. These installations are similar, so learning to do one will help you do another. Here are the general procedures to install any peripheral device:

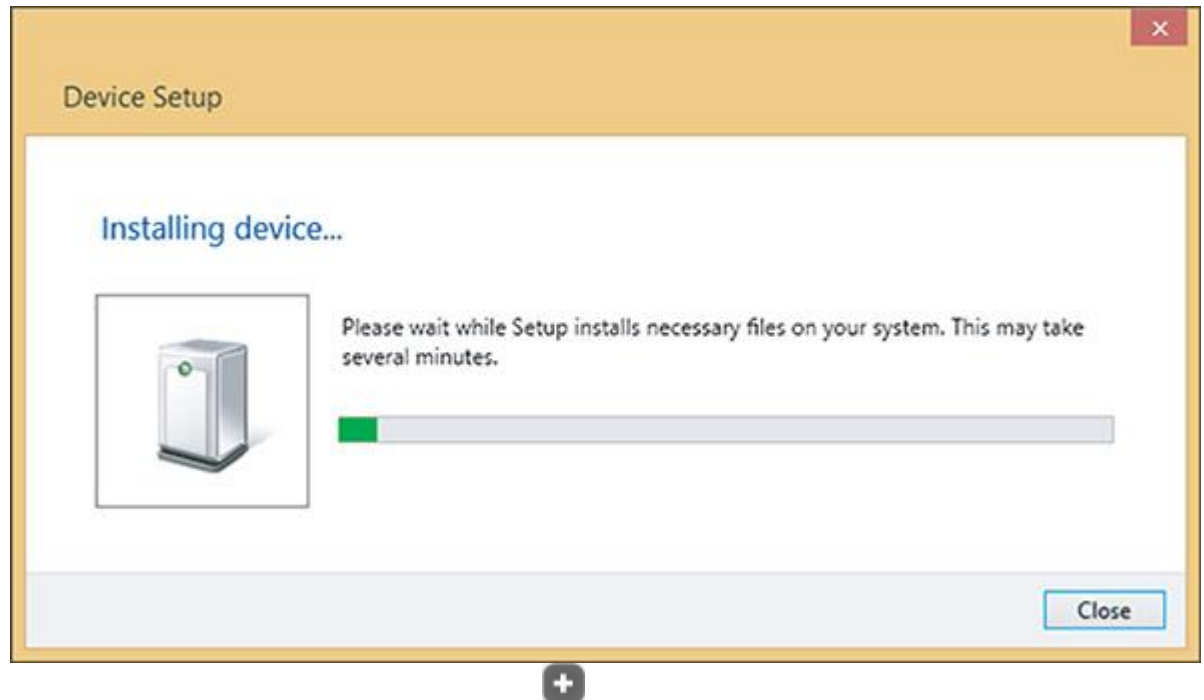
1. **Read the manufacturer's directions.** I know you don't want to hear that again, but when you follow these directions, the installation goes smoother. If you later have a problem with the installation and you ask the manufacturer for help, being able to say you followed the directions exactly as stated goes a long way toward getting more enthusiastic help and cooperation.
2. **Make sure the drivers provided with the device are written for the OS you are using.** Recall that 64-bit drivers are required for a 64-bit OS, and 32-bit drivers are required for a 32-bit OS. You can sometimes use drivers written for older Windows versions in newer Windows versions, but for best results, use drivers written for the OS installed. You can download the drivers you need from the manufacturer's website.
3. **Make sure the motherboard port you are using is enabled.** It is most likely enabled, but if the device is not recognized when you plug it in, go into BIOS/UEFI setup and make sure the port is enabled. In addition, BIOS/UEFI setup might offer the option to configure a USB port to use USB4, SuperSpeed+ (USB or 3.2 or 3.1), SuperSpeed (USB 3.0), Hi-Speed USB (USB 2.0), or original USB (USB 1.1). Refer back to [Figure 6-6](#), which shows the BIOS setup screen for one system where you can enable or disable onboard devices. In addition, if you are having problems with a motherboard port, don't forget to update the motherboard drivers that control the port.
4. **Install drivers or plug in the device.** Some 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 scanner says that if you install the scanner before installing the drivers, the drivers will not install properly.

If you plug in the device first, Device Setup launches and steps you through the installation of drivers (see [Figure 6-13](#)). As Device Setup

works, an icon appears in the taskbar. To see the Device Setup dialog box, as shown in the figure, click the icon.

Figure 6-13

Device Setup begins installing a new device



If you need to install the drivers first, run the setup program on CD or DVD. If you downloaded drivers from the web, double-click the driver file and follow the directions on-screen. 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. If you have problems using the device, turn to Device Manager for help.

5. **Install the application software to use the device.** For example, a USB camcorder is likely to come bundled with video-editing software. Run the software to use the device.

Now let's look at some key features and any specific installation concerns for several peripheral devices.

6-2a Mouse or Keyboard

Core 1 Objective

- 1.1

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

When you plug a mouse or keyboard into a USB port, Windows should immediately recognize it and install generic drivers. (Older computers used

PS/2 ports for the mouse and keyboard. Because these ports were not hot-pluggable, you had to restart Windows after plugging in a mouse or keyboard.) For keyboards with special features such as the one shown in [Figure 6-14](#), you need to install the drivers that came with the keyboard before you can use these features.

Figure 6-14

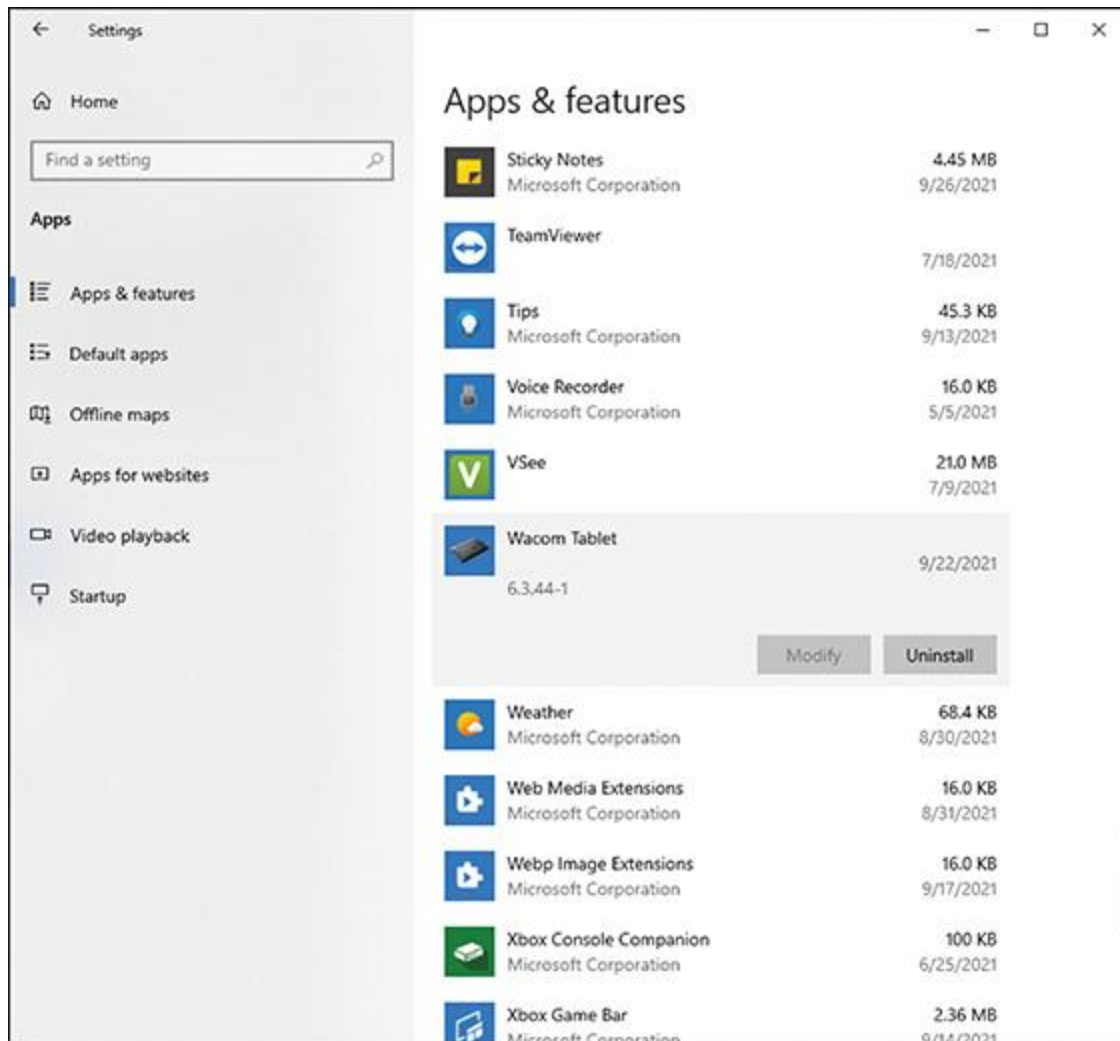
The mouse and keyboard require drivers to use the extra buttons and zoom bar



You can use Device Manager to uninstall, disable, or enable most devices. However, USB devices are managed differently. To uninstall a USB device such as a USB graphing tablet, use the Programs and Features window or the Apps & features window. To open the Windows 10 Apps & features window, right-click the **Start** button, select **Apps and Features**, and then select the device and click **Uninstall**. See [Figure 6-15](#). Follow the directions on-screen to uninstall the device.

Figure 6-15

USB devices are listed as installed programs



Note 3

The A+ Core 1 exam expects you to use Control Panel in Classic view, which presents a list of individual items. If Control Panel is in Category view, which presents items in groups, you can get Classic view by clicking **Category** and then clicking **Small icons** or **Large icons**.

Replace a Key or the Keyboard and Touch Pad in a Laptop

When individual keys are broken, you can replace just the key fairly easily. Before you begin any disassembly of a laptop, refer to the manufacturer documentation. Follow these standard steps that are similar for many models of laptops:

1. 1 Slide a small flathead screwdriver underneath the key cap to hold down the key retainer clip, and then pull up on the key cap.
2. 2

If the key retainer clip is broken, pop it off and replace it, being careful to not pull on the rubber cup.

3. **3**
Pop a new key cap on the key retainer clip.

Replacing the whole keyboard is pretty easy, too. Always follow the steps provided by the manufacturer when disassembling a laptop. Here are the steps for a Lenovo laptop that are similar for many models of laptops:

1. **1**
Power down the laptop, and remove the AC adapter and the battery pack.
2. **2**
Remove two or more screws on the bottom of the laptop. (Only the manufacturer documentation can tell you which ones because there are probably several used to hold various components in place.)
3. **3**
Remove the lid on the bottom of the laptop to expose the keyboard ribbon cable attached underneath the board. Use a screwdriver, spudger, or tweezers to lift the cable connector up and out of its socket (see [Figure 6-16](#)).

Figure 6-16

Disconnect the keyboard cable from the motherboard



4. **4**

Turn the laptop over and open the lid. Use a spudger to gently pry the keyboard bezel away from the case (see [Figure 6-17](#)).

Figure 6-17

Use a spudger to pry up the keyboard bezel



5. **5** Lift the keyboard bezel from the case (see [Figure 6-18](#)).

Figure 6-18

Lift the keyboard from the case



6. **6** Replace the keyboard following the steps in reverse order.

Sometimes the touch pad and keyboard are one complete field replaceable unit (FRU). If the touch pad is a separate component, it might be part of the keyboard bezel, also called the palm rest. This bezel is the flat cover that surrounds the keyboard. You most likely have to remove the keyboard before you can remove the keyboard bezel.

6-2b Webcams

Core 1 Objective

- 1.2

Compare and contrast the display components of mobile devices.

A webcam (web camera) is embedded in most laptops and can also be installed as a peripheral device using a USB port or some other port. For example, the webcam shown in [Figure 6-19](#) works well for personal chat sessions and videoconferencing and has a built-in microphone. First, install the software, and then plug in the webcam to a USB port.

Figure 6-19

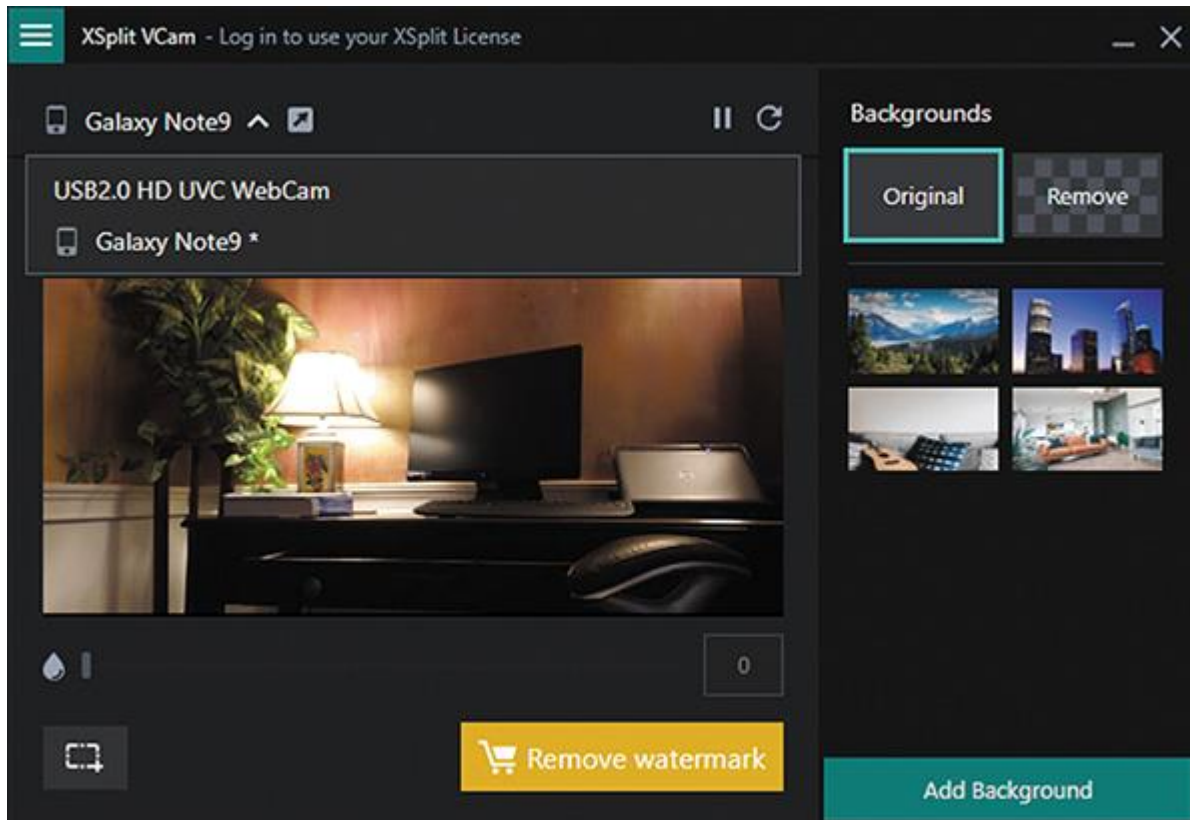
This personal web camera clips to the top of your laptop and has a built-in microphone



A webcam comes with a built-in microphone. You can use this microphone or the microphone port on the computer. Most software for using a webcam and microphone allows you to select these input devices. For example, [Figure 6-20](#) shows the input options for VCam by XSplit ([xsplit.com](https://www.xsplit.com)).

Figure 6-20

The VCam application by XSplit allows you to change the input devices used for video and sound



6-2c Graphics Tablets

Core 1 Objective

- 1.2

Compare and contrast the display components of mobile devices.

Another input device is a **graphics tablet**, also called a **digitizing tablet** or **digitizer**, which is used to hand draw. It is likely to connect using a USB port (see [Figure 6-21](#)). It comes with a **stylus** that works like a pencil on the tablet and controls the pointer on the screen. The graphics tablet and stylus can be a replacement for a mouse or touch pad on a laptop, and some graphics tablets come with a mouse. Graphics tablets are popular with

graphic artists and other content creators who use desktop publishing applications.

Figure 6-21

A graphics tablet and stylus are used to digitize a hand drawing



Install the graphics tablet the same way you do other USB devices. Additional software might be bundled with the device to enhance its functions, such as inputting handwritten signatures into Microsoft Word documents.

6-3 Installing and Configuring Adapter Cards

Core 1 Objectives

- 1.1
Given a scenario, install and configure laptop hardware and components.
- 1.2
Compare and contrast the display components of mobile devices.
- 3.4
Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.

In this section of the module, you learn to install and configure adapter cards. These types of cards include video cards, sound cards, network interface cards (NIC), capture cards, and USB expansion cards. The purpose of adding an adapter card to a system is to add external ports or internal connectors the card provides.

Regardless of the type of card you are installing, be sure to verify and do the following when preparing to install one:

- **Verify that the card fits an empty expansion slot.** Recall that there are several PCI and PCI Express standards; therefore, make sure the card will fit the slot. To help with airflow, 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. PCIe slots on a motherboard might support different PCIe standards. The motherboard manual tells you which slot is rated for which PCIe standard.
- **Verify that the device drivers for your OS are available.** Check the card documentation, and make sure you have the drivers for your OS. For example, you need to install 64-bit Windows 10 device drivers in a 64-bit installation of Windows 10. You might find drivers to download for your OS from the website of the card manufacturer.
- **Back up important data that is not already backed up.** Before you open the computer case, be sure to back up important data on the hard drive.
- **Know your starting point.** Know what works and what doesn't work on the system. Can you connect to the network and the Internet, print, and use other installed adapter cards without errors? After installing a new card, verify your starting point again before installing another card.

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

- 1.
Read the documentation that came with the card. For most cards, you install the card first and then the drivers, but some installations might not work this way.
- 2.
If you are installing a card to replace an onboard port, access BIOS/UEFI setup and disable the port.
- 3.
Wear an ESD strap as you work to protect the card and the system against ESD. Shut down the system, unplug power cords and cables, and press the power button to drain the power. Remove the computer case cover.
- 4.
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 or raise the clip on the top of the slot. Save the screw; you'll need it later.

- 5.

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 the card 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.

Recall that PCIe $\times 16$ slots use a retention mechanism in the slot to help stabilize a heavy card (see [Figure 6-22](#)). For these slots, 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. [Figure 6-23](#) shows a PCIe video card installed in a PCIe $\times 16$ slot.

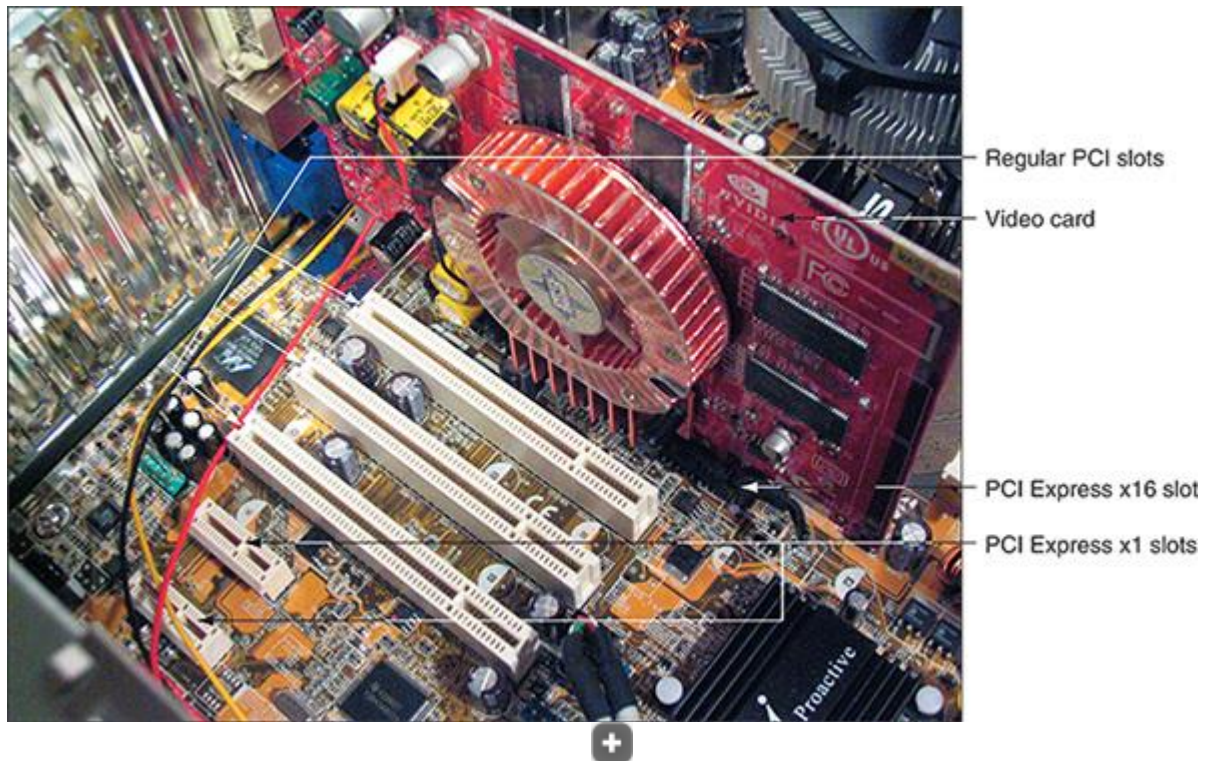
Figure 6-22

A white retention mechanism on a PCIe $\times 16$ slot pops into place to help stabilize a heavy video card



Figure 6-23

A PCIe video card installed in a PCIe $\times 16$ slot

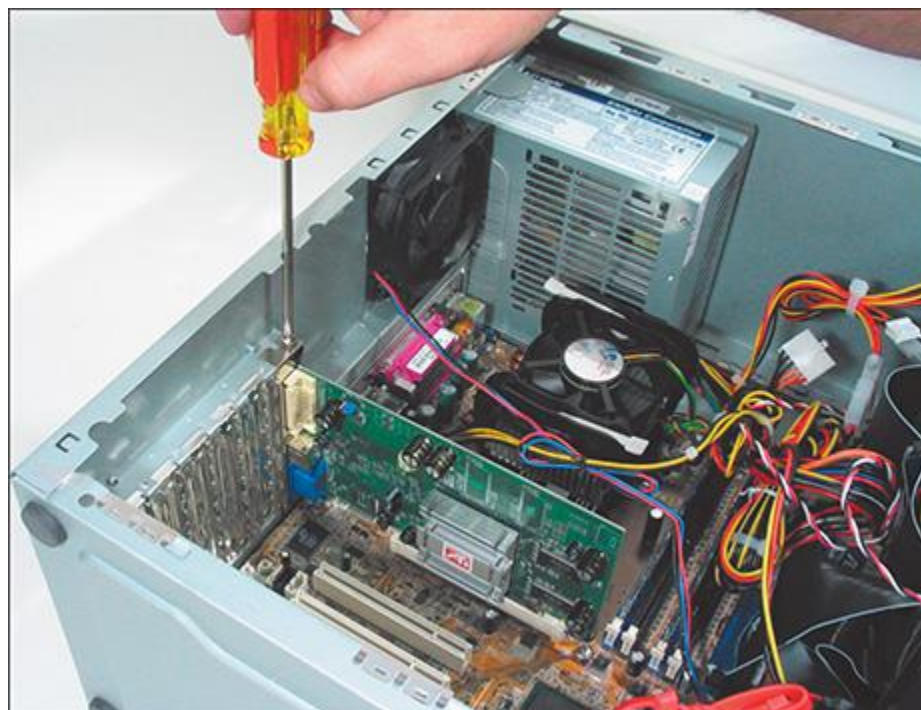


- 6.

Insert the screw that anchors the card to the top of the slot (see [Figure 6-24](#)). Be sure to use this screw. If it's not present, the card can creep out of the slot over time, causing a loose connection.

Figure 6-24

Secure the card to the case with a single screw

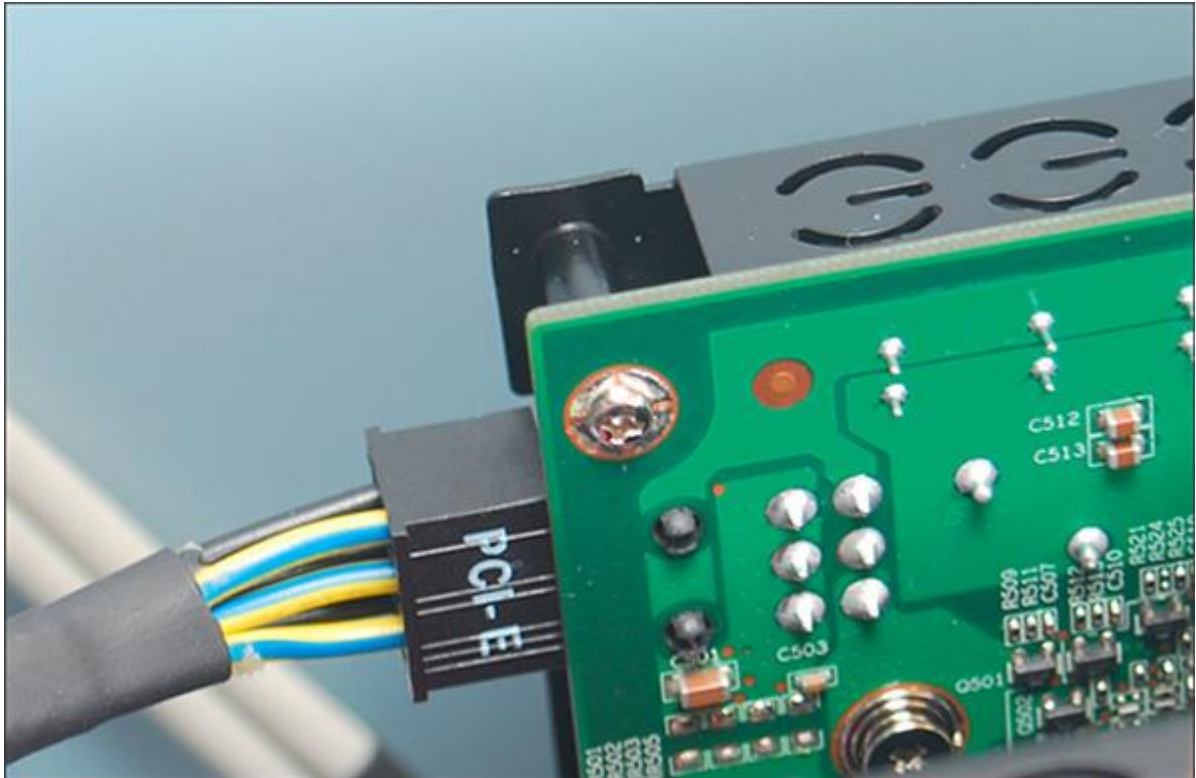


- 7.

Connect any power cords or data cables the card might use. For example, a video card might have a 6-pin or 8-pin PCIe power connector for a power cord from the power supply to the card, as shown in [Figure 6-25](#).

Figure 6-25

Connect a power cord to the PCIe power connector on the card



Note 4

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.

- 8.
Make a quick check of all connections and cables, and then replace the case cover. (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.) Plug up the external power cable and essential peripherals.
- 9.
Start the system. When Windows starts, it should detect that a new hardware device is present and attempt to automatically install the drivers. As the drivers are installed, a message might appear above the taskbar. When you click the message, the Device Setup dialog box appears (refer back to [Figure 6-13](#)). You can cancel the wizard and manually install the drivers.

- 10.

Download the drivers from the manufacturer website, or insert the CD that came bundled with the card and launch the setup program. The card documentation will tell you the name of the program (examples are Setup.exe and Autorun.exe). [Figure 6-26](#) shows the opening menu for one setup program for a video card. Follow the on-screen instructions to install the drivers.

Figure 6-26

An opening menu to install video drivers



Source: NVIDIA

Note 5

All 64-bit drivers must be certified by Microsoft to work in Windows. However, some 32-bit drivers might not be certified. During the driver installation, if you see a message that 32-bit drivers have not been certified, go ahead and give permission to install the drivers if you obtained them from the manufacturer or another reliable source.

- 11.

After the drivers are installed, you might be asked to restart the system. Then you can configure the card or use it with application software. If you have problems with the installation, turn to Device Manager and look for errors reported about the device. The card might not be properly seated in the slot.

Now let's turn our attention to types of cards you might be called on to install. As with any adapter card you install, be sure to become familiar with the user guide before you start the installation so you know the card's hardware and software requirements and what peripheral devices it supports.

6-3a Sound Cards and Onboard Sound

Core 1 Objective

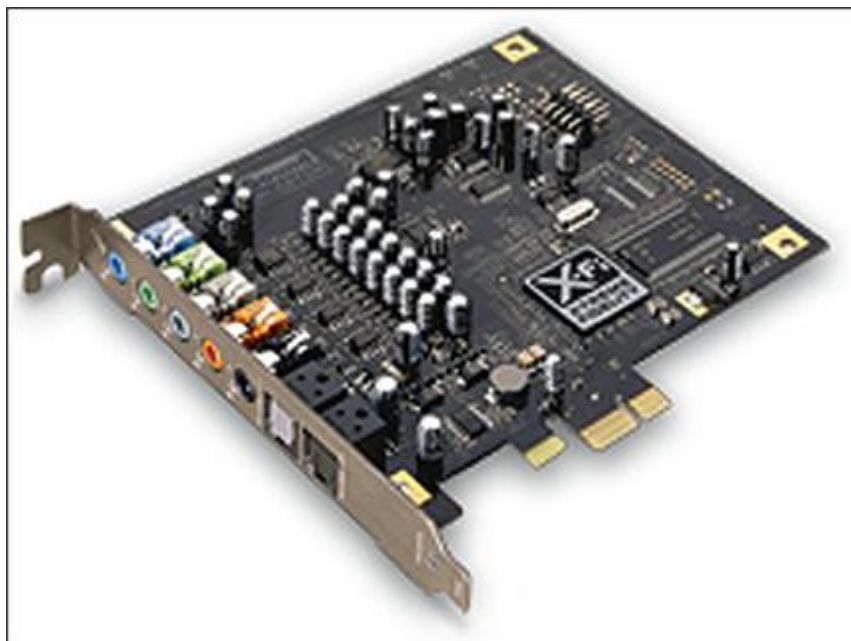
- 3.4

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

A **sound card** (an expansion card with sound ports) or onboard sound (sound ports embedded on a motherboard) can play and record sound and save it in a file. [Figure 6-27](#) shows a sound card by Creative (creative.com). This Sound Blaster card uses a PCIe $\times 1$ slot and supports up to eight surround sound speakers. The color-coded speaker ports are for these speakers: front left and right, front center, rear left and right, subwoofer, and two additional rear speakers. The two SPDIF (Sony-Philips Digital InterFace) ports are used to connect to external sound equipment such as a Blu-ray disc player.

Figure 6-27

The Sound Blaster X-Fi Titanium sound card by Creative uses a PCIe $\times 1$ slot



Note 6

If you are using a single speaker or two speakers with a single sound cable, connect the cable to the lime-green sound port on the motherboard, which is usually the middle port.

6-3b Capture Cards

Core 1 Objective

- 3.4

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

A **capture card** is a peripheral device or an expansion card used to record and stream content from an external device, such as a gaming console or webcam. Capture cards are primarily used by video game streamers. Some capture cards use a PCIe port on the motherboard. [Figure 6-28](#) shows a capture card by AVerMedia ([avermedia.com](https://www.avermedia.com)).

Figure 6-28

This capture card by AVerMedia uses a PCIe slot to connect to the computer



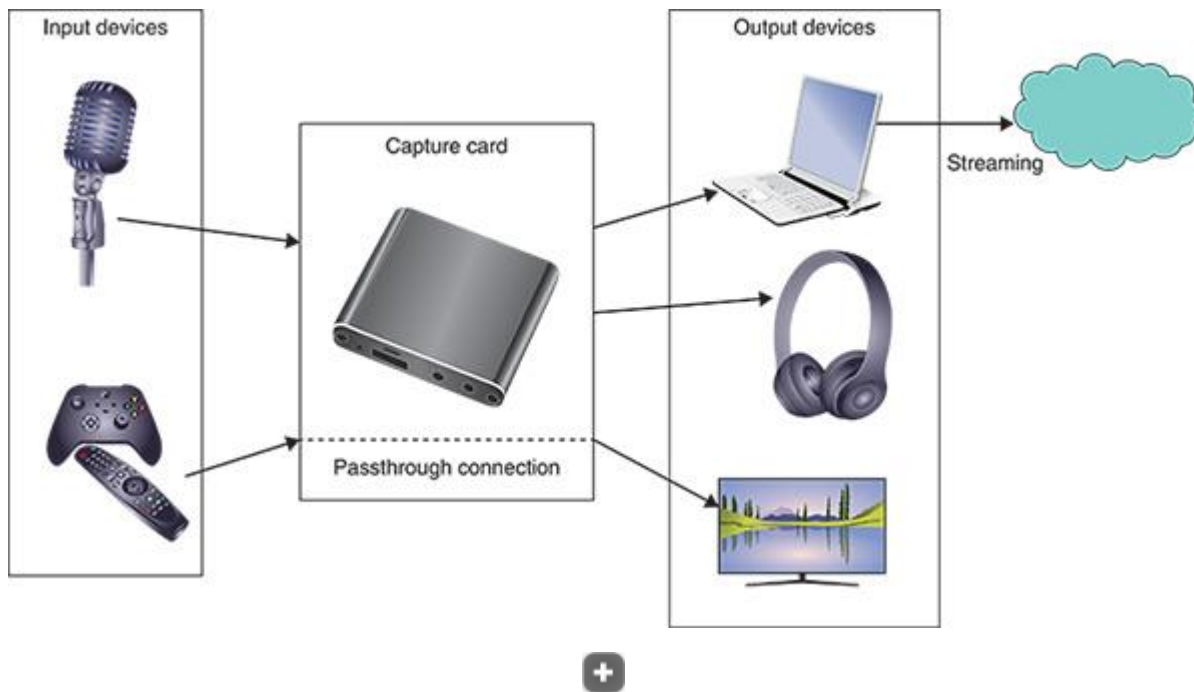
Source: [Amazon.com](https://www.amazon.com), Inc.

Another type of capture card is a peripheral device that connects to the computer using a USB, USB-C, or Thunderbolt port. Capture cards have a

passthrough between the source of content (e.g., a gaming console or camera) and the display, typically using HDMI in/out connections. The data is sent via the passthrough to the computer to record and stream (see [Figure 6-29](#)). Some capture cards also offer ports for input from a microphone and output to a headset.

Figure 6-29

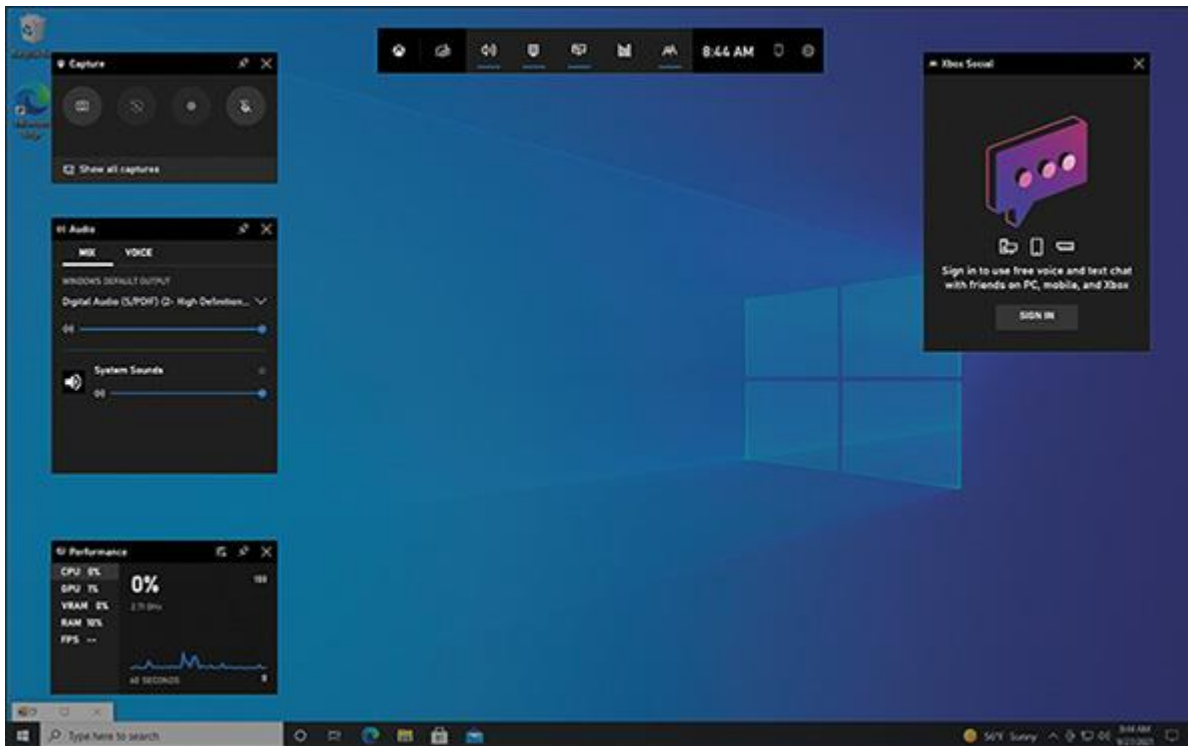
Connections on a capture card



After installing a capture card, you can download and use the proprietary software that comes with the card, or you can choose third-party software. Third-party software is usually more robust than proprietary software offered by the manufacturer. Windows 10 offers Xbox Game Bar for recording (see [Figure 6-30](#)). To open Microsoft Xbox Game Bar, press the **Windows key+G**.

Figure 6-30

Windows Game Bar can be used for recording



Exam Tip

The A+ Core 1 exam expects you to be able to determine when you would need to replace a Mini PCIe card in a laptop given a scenario.

6-3c Replacing Expansion Cards in a Laptop

Core 1 Objective

- 1.1

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

A laptop does not contain the normal PCI Express or PCI slots found in desktop systems. Many laptops provide **Mini PCI Express** slots (also called **Mini PCIe** slots) that use the PCI Express standards applied to laptops. Mini PCI Express slots use **52 pins** on the edge connector. These slots can be used by many kinds of Mini PCIe cards. These cards are often used to enhance communications options for a laptop, including Wi-Fi wireless, video, and Bluetooth Mini PCIe cards. [Figure 6-31](#) shows a Mini PCI Express card by Sierra Wireless that provides mobile broadband Internet.

Figure 6-31

The MC8775 Mini PCI Express card by Sierra Wireless used for voice and data transmissions on cellular networks

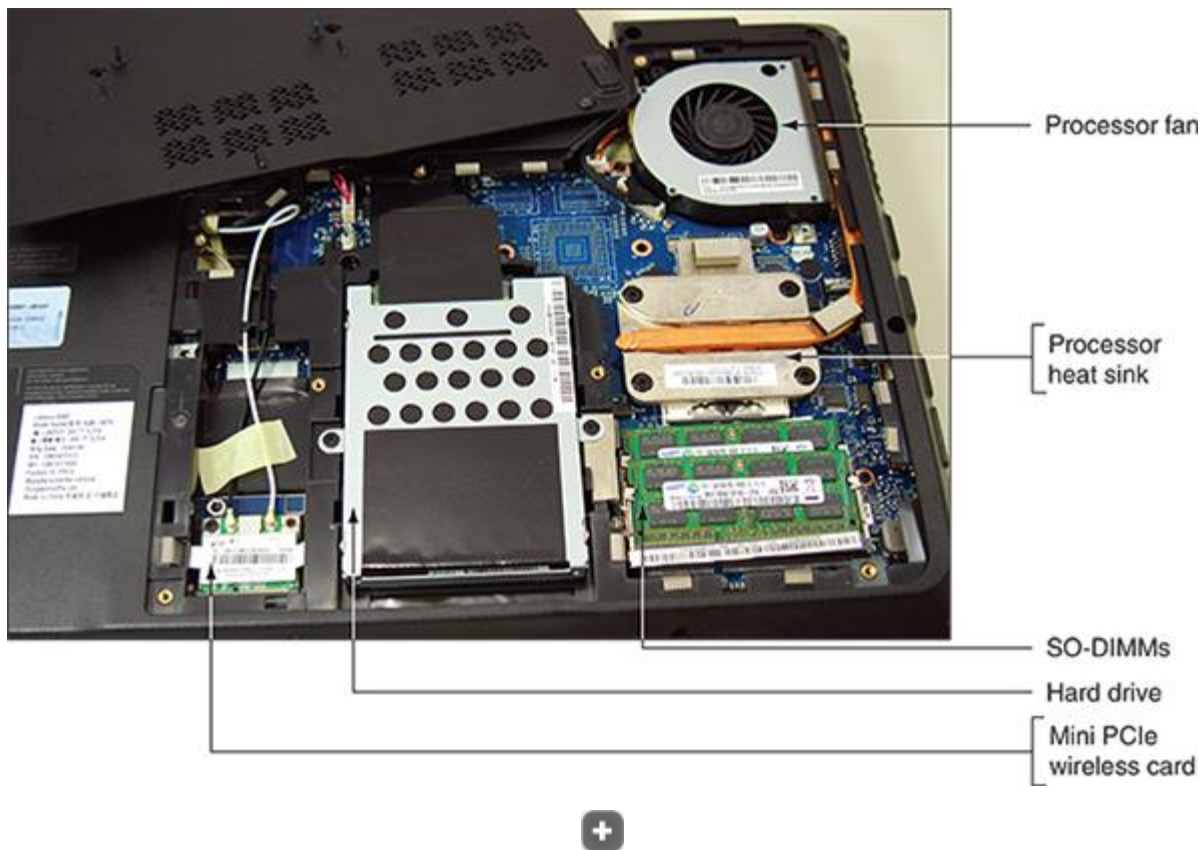


Source: Sierra Wireless

For many laptops, you can remove a cover on the bottom to expose expansion cards so that you can exchange them without an extensive disassembly. For example, to remove the cover on the bottom of one Lenovo laptop, first remove several screws, and then lift the laptop cover up and out. Several internal components are exposed, as shown in [Figure 6-32](#).

Figure 6-32

Removing the cover from the bottom of a laptop exposes several internal components



The half-size Mini PCIe wireless Wi-Fi card shown in [Figure 6-33](#) has two antennas. To remove the card, first disconnect the black and the gray antenna wires, and remove the one screw shown in the photo. Note the black and white triangles labeled with a 1 and a 2 on the label of the card so you know which wire goes on which connector when replacing the card. Typically, the black antenna wire goes to the black triangle, and the gray antenna wire goes with the white triangle. Then slide the card forward and out of the slot. You can then install a new card.

Figure 6-33

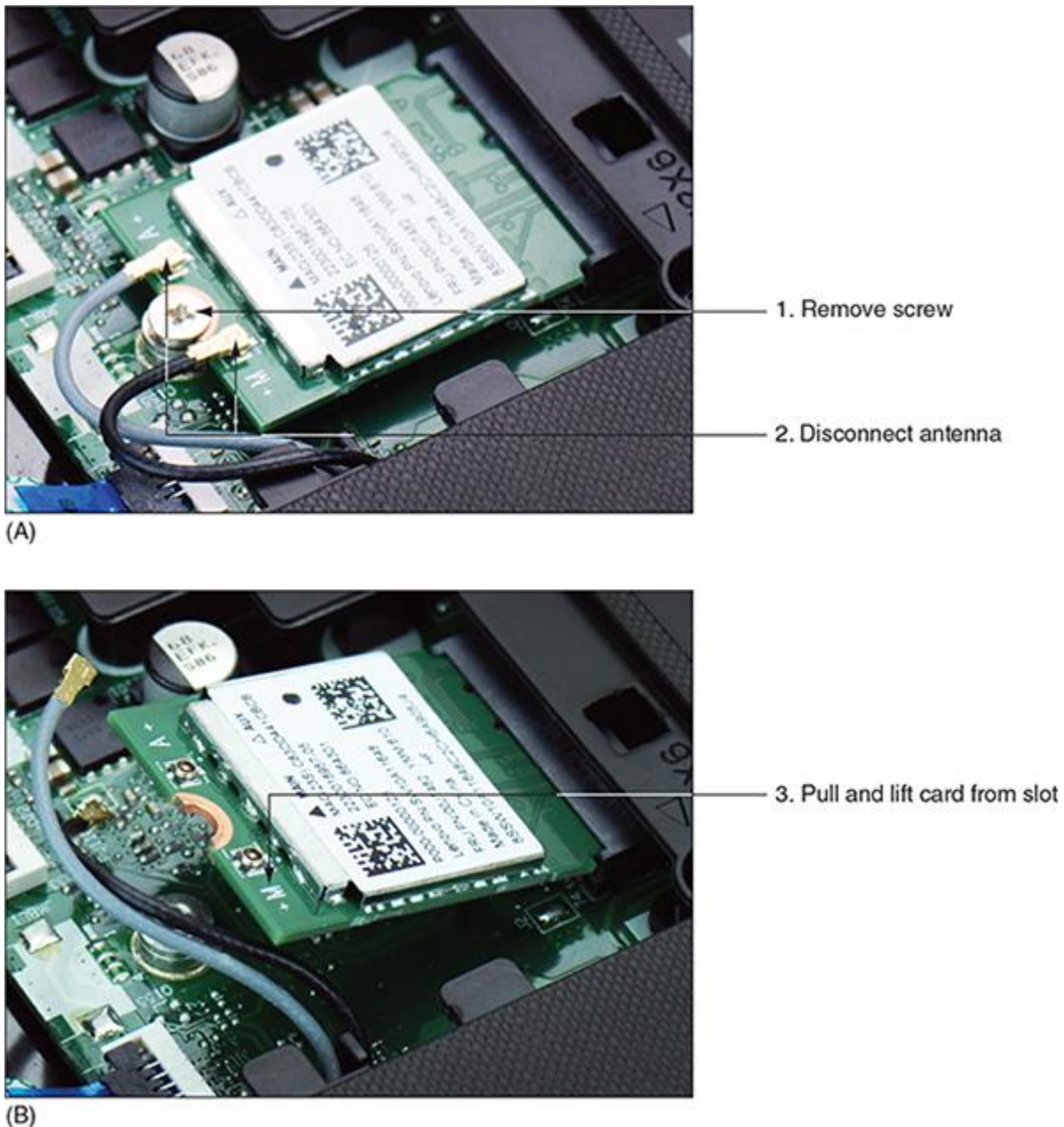
This half-size Mini PCIe wireless card is anchored in the expansion slot with one screw



[Figure 6-34](#) shows another Mini PCIe card installed in a laptop. First remove the one screw at the top of the card and disconnect the two antenna wires, and then pull the card forward and out of the slot.

Figure 6-34

How to remove a Mini PCI Express card



After you have installed a Mini PCIe card that is a Bluetooth or other wireless adapter, try to connect the laptop to the wireless network. If you have problems making a connection, verify that Device Manager reports the device is working properly and that Event Viewer has not reported error events about the device.

6-4 Supporting the Video Subsystem

Core 1 Objectives

- 1.2

Compare and contrast the display components of mobile devices.

- 3.1

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

- 3.4

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

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 adapter and graphics card) or a video port on the motherboard. In this section of the module, you learn about monitors and how to support the video subsystem.

6-4a Monitor Technologies and Features

Core 1 Objectives

- 1.2

Compare and contrast the display components of mobile devices.

- 3.1

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

The most popular type of monitor for laptop and desktop systems is an LCD flat-screen monitor (see [Figure 6-35](#)), but you have other choices as well. Here is a list and description of each type of display:

Figure 6-35

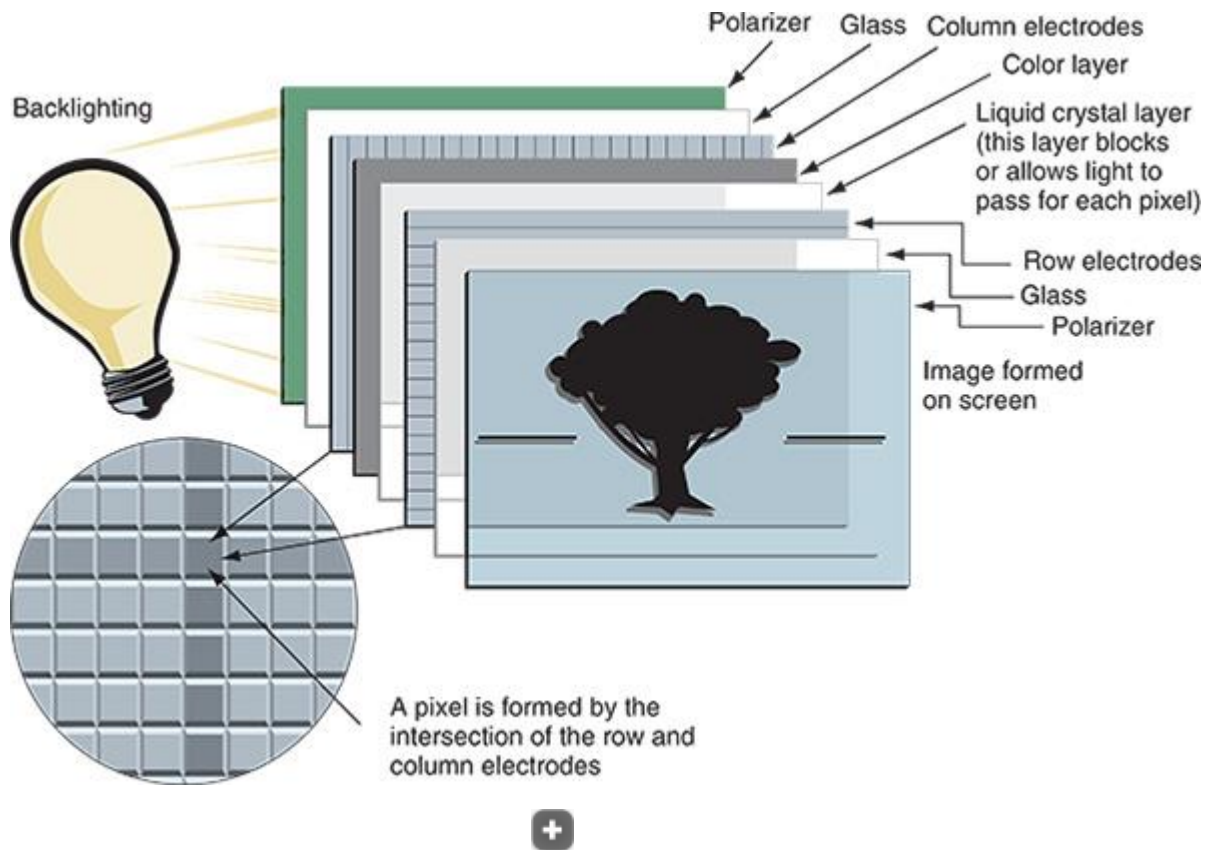
An LCD monitor



- **LCD monitor.** The **LCD (liquid crystal display) monitor**, also called a **flat-panel monitor**, was first used in laptops. The monitor produces an image using a liquid crystal material made of large, easily polarized molecules. [Figure 6-36](#) 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 forming columns and rows. Each intersection of a row electrode and a column electrode forms one **pixel** on the LCD panel. Software can address each pixel to create an image.

Figure 6-36

Layers of an LCD panel



The following are the three common types of LCD monitors:

- **Twisted nematic (TN).** **Twisted nematic (TN)** monitors are the oldest type of LCD monitor and are still widely popular because they are inexpensive and easy to produce. They have lowest latency and highest refresh rates among LCD monitors. The viewing angles and color range of TN monitors are lacking.
- **In-plane switching (IPS).** **In-plane switching (IPS)** monitors improved on TN monitors in terms of viewing angles and color range. In addition, IPS monitors provide the most accurate color and the best LED (light-emitting diode) backlighting for viewing photography; however, these types of monitors also have an “IPS glow” at extreme viewing angles. IPS monitors, which are quickly closing the gap with TN monitors in latency and refresh rates, are the most expensive option.
- **Vertical alignment (VA).** **Vertical alignment (VA)** monitors are a compromise between TN and IPS monitors. VA monitors are ideal for general use and in TVs. They offer the best contrast ratio and picture depth. VA monitors offer better color range than TN monitors, and they do not have the IPS glow. They have poor latency, which creates motion blur or ghosting on fast-moving pictures, making them unpopular among competitive gamers.
- **OLED monitor.** An **OLED (organic light-emitting diode)** monitor uses a thin LED (light-emitting diode) layer or film between two grids

of electrodes and does not use backlighting. It does not emit as much light as an LCD monitor and, therefore, can produce deeper blacks, provide better contrast, work in darker rooms, and use less power than an LCD monitor. On the other hand, LCD monitors give less glare than OLED monitors. OLED screens are primarily used by mobile devices and other portable electronic devices. OLED monitors are available for desktop systems but are significantly more expensive than LCD monitors.

- **Projector.** A digital **projector** (see [Figure 6-37](#)) shines a light that projects a transparent image onto a large screen and is often used in classrooms or with other large groups. Several types of technologies are used by projectors, including LCD. A projector is often installed as a dual monitor on a computer, which you learn how to do later in the module.

Figure 6-37

A portable XGA projector by Panasonic



Source: Courtesy of Panasonic Corporation of North America

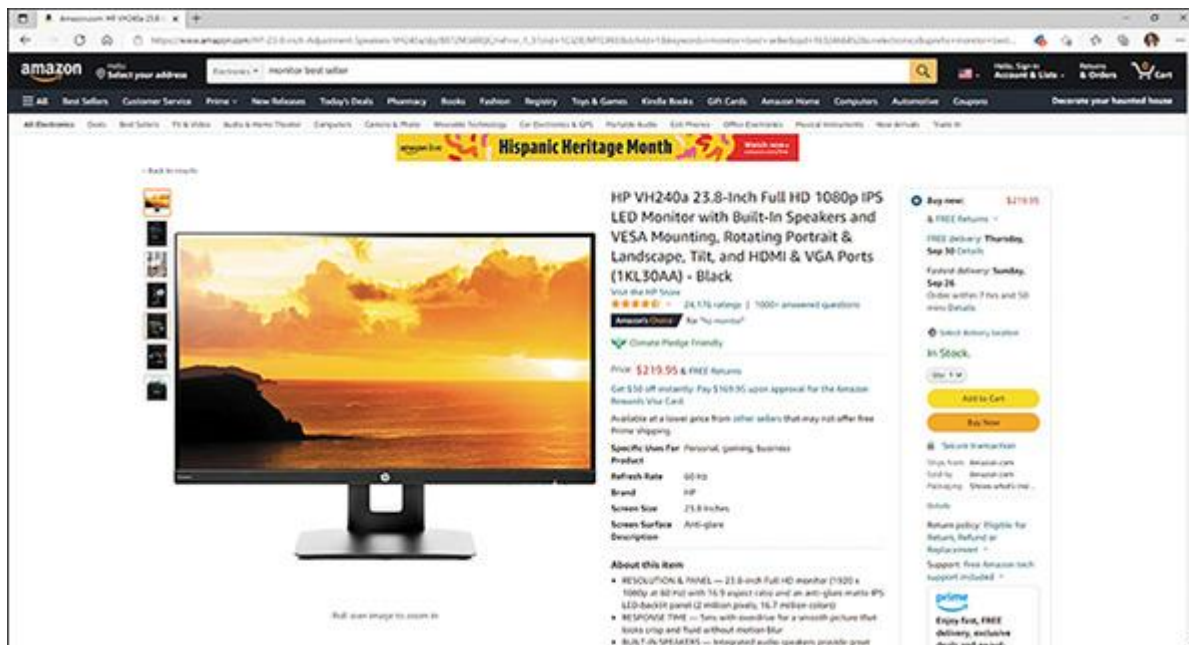
Exam Tip

The A+ Core 1 exam expects you to compare LCD and OLED monitor types and choose which one is the best fit for a given scenario.

Although a laptop display almost always uses LCD technology, laptops that use an OLED display are available. Some laptop LCD panels use LED backlighting to improve display quality and conserve power. For desktops, LCD is by far the most popular monitor type. [Figure 6-38](#) shows an ad for one best-selling LCD monitor. [Table 6-3](#) explains the features mentioned in the ad.

Figure 6-38

An ad for a monitor lists the monitor's features



Source: [Amazon.com](https://www.amazon.com), Inc.

Table 6-3

Important Features of a Monitor

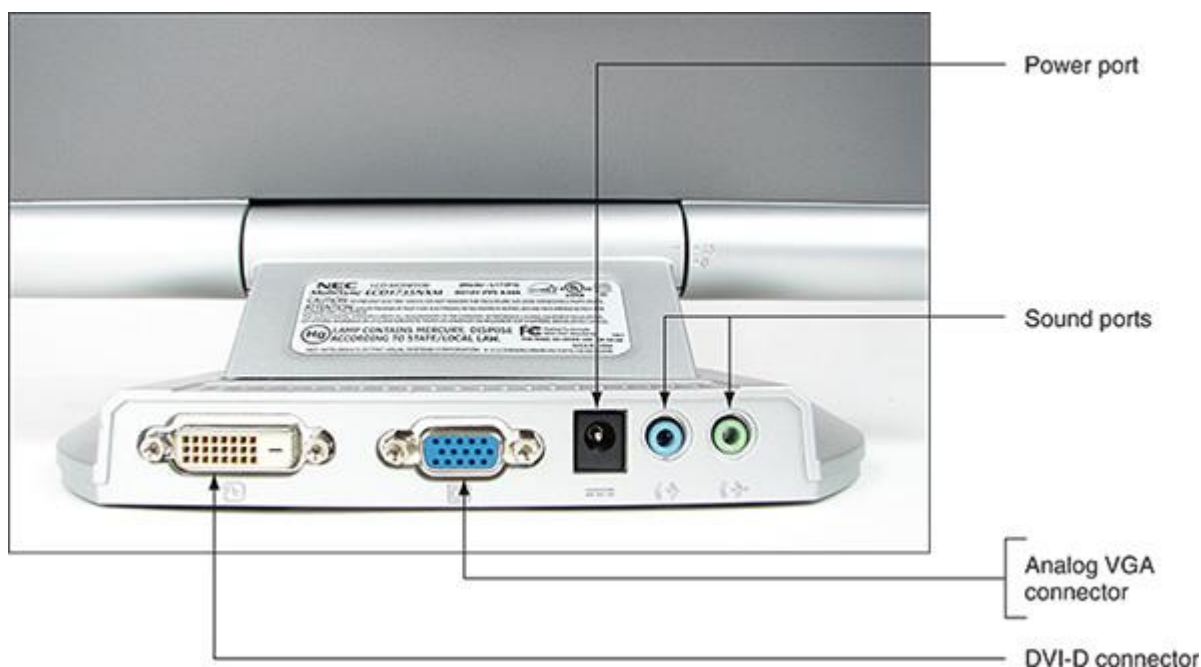
Monitor Characteristic	Description
Screen size	The screen size is the diagonal length of the screen surface in inches.
Refresh rate	The refresh rate is the number of times a monitor screen is built or refreshed in 1 second, measured in Hz (cycles per second). The ad in Figure 6-38 shows the monitor refresh rate as 60 Hz (60 frames per second)—the higher, the better. Related to refresh rate, the response time is the time it takes to build one frame, measured in milliseconds (ms)—the lower, the better. The ad in Figure 6-38 shows a response time of 5 ms.
Pixel pitch	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—the smaller the number, the better.
Resolution	The resolution is the number of spots or pixels on a screen that can be addressed by software. Values can range from 640 × 480 up to 7680 × 4320 for high-end monitors. Popular resolutions are 1280 × 720 and 1920 × 1080. The resolution in Figure 6-38 is 1920 × 1080.
Contrast ratio	<p>Contrast ratio is the contrast between true black and true white on the screen—the higher the contrast ratio, the better. 1000:1 is better than 700:1.</p> <p>An advertised dynamic contrast ratio is much higher than the contrast ratio, but it is not a true measurement of contrast. Dynamic contrast adjusts the backlighting to give the effect of an overall brighter or darker image. For example, if the contrast ratio is 1000:1, the dynamic ratio is 20,000,000:1. When comparing quality of monitors, pay more attention to the contrast ratio than the dynamic ratio.</p>
Viewing angle	The viewing angle is the angle at which a monitor becomes difficult to see from the side. A viewing angle of 170 degrees is better than 140 degrees.

Monitor Characteristic	Description
Backlighting or brightness	Brightness is measured in cd/m^2 (candela per square meter), which is the same as lumens/m^2 (lumens per square meter).
Connectors	Popular options for connectors are VGA, DVI-I, DVI-D, HDMI, DisplayPort, and Thunderbolt. Some monitors offer more than one connector (see Figure 6-39).
Other features	LCD monitors can also provide a privacy or antiglare surface, tilt screens, microphone input, speakers, USB ports, adjustable stands, and perhaps even an input for your smartphone. Some monitors are also touch screens, so they can be used with a stylus or finger touch.



Figure 6-39

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



Exam Tip

The A+ Core 1 exam expects you to know about the components within the display of a laptop, including the components used in LCD and OLED displays. You also need to know about backlighting and the function of an inverter.



Exam Tip

The A+ Core 1 exam expects you to know about monitor features such as refresh rate, resolution, brightness in lumens, and connectors used.

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 low response time. The lower refresh rates that cause monitor flicker can tire and damage your eyes. When you first install a monitor, set the refresh rate at the highest value the monitor can support.

Now let's see how to configure a monitor or dual monitors connected to a Windows computer.

6-4b Changing Monitor Settings

Core 1 Objective

- 1.2

Compare and contrast the display components of mobile devices.

Settings that apply to the monitor can be managed by using the monitor buttons, function keys on a keyboard, 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. Adjust these settings to correct a distorted image. For laptops, the brightness and contrast settings can be changed using function keys on the laptop.



Applying Concepts

Installing Dual Monitors

- **Est. Time:** 30 minutes
- **Core 1 Objective:** 1.2

To increase the size of your Windows desktop, you can install more than one monitor for a single computer. To install dual monitors, you need two video ports on your system, which can come from motherboard video ports, a video card that provides two video ports, or two video cards.

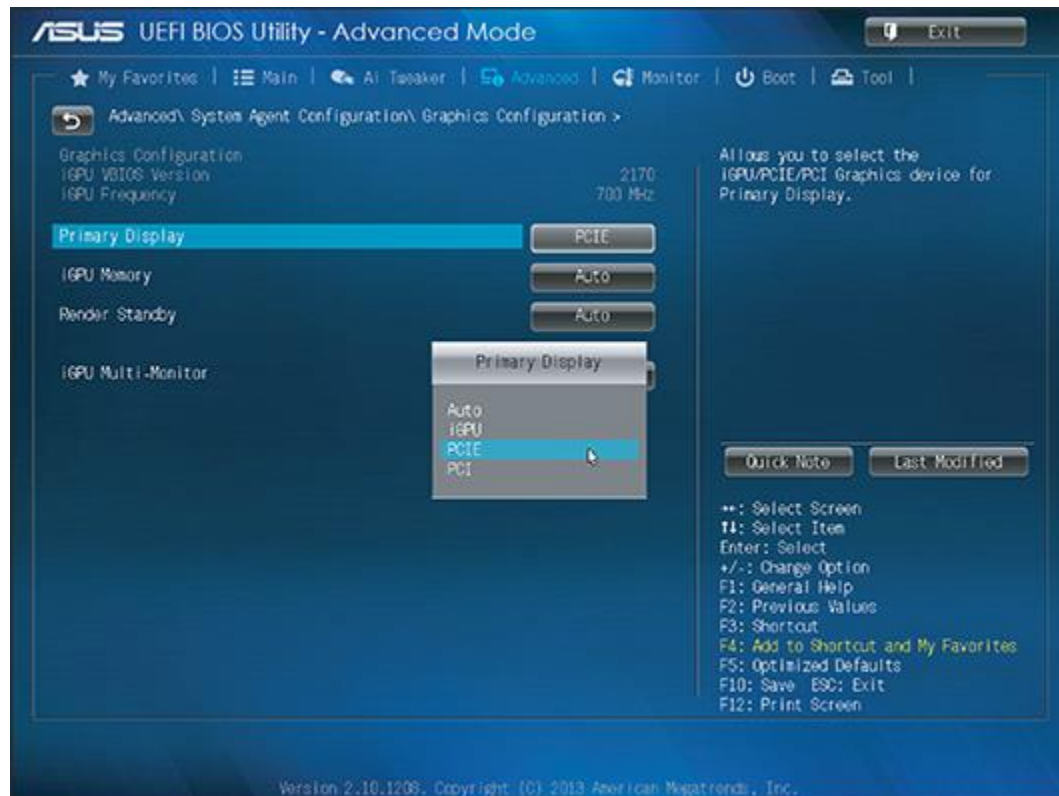
To install a second monitor in a dual-monitor setup using two video cards, follow these steps:

1.  Verify that the original video card works properly, and decide whether it will be the primary monitor.
2.  Boot the computer and enter BIOS/UEFI setup. If BIOS/UEFI setup has the option to select the order in which video cards are initialized, verify that the currently installed card is configured to initialize first. For example, for the BIOS/UEFI system in [Figure 6-40](#), the video adapter in the PCIe slot initializes first before other video adapters. If it

does not initialize first and you install the second card, video might not work at all when you first boot with two cards.

Figure 6-40

In BIOS/UEFI setup, verify that the currently installed video adapter is set to initialize first



Source: American Megatrends, Inc.

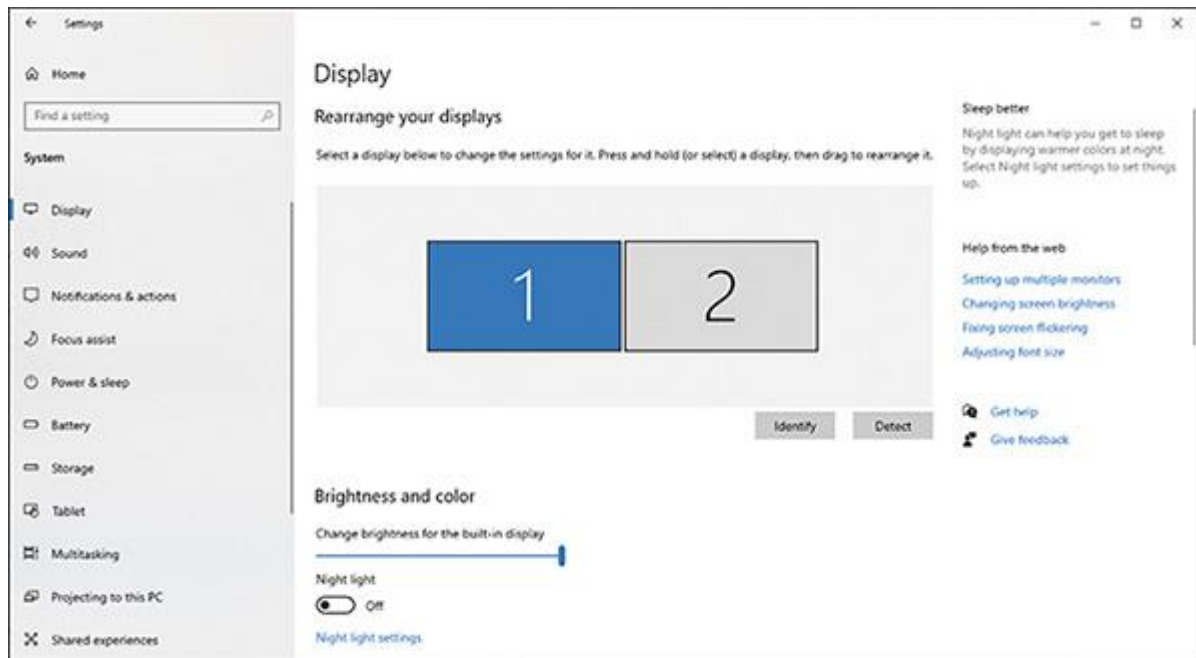
3. **3** Install a second video card in an empty slot. A computer might have a second PCIe slot or an unused PCI slot you can use. Attach the second monitor.
4. **4** Boot the system. Windows recognizes the new hardware and launches Device Setup. You can use the utility to install the video card drivers or cancel the utility and install them manually, as you learned to do earlier in the module.

Here are the steps to configure dual monitors:

1. **1** Connect two monitors to your system. In Windows 10, open the **Settings** app, and click the **System** group. The display settings appear, as shown in [Figure 6-41](#).

Figure 6-41

Configure each monitor in a dual-monitor configuration



2. **2**

Notice the two numbered boxes that represent your two monitors. When you click one of these boxes, the settings shown apply to the selected monitor, and the screen resolution and orientation (Landscape, Portrait, Landscape flipped, or Portrait flipped) follow the selected monitor. This lets you customize the settings for each monitor separately. If necessary, use drag-and-drop to arrange the boxes so they represent the physical arrangement of your monitors.

Note 7

If you see both numbered displays in the same box, the Multiple displays setting is set to Duplicate these displays. To separate the displays, change the Multiple displays setting to **Extend these displays**. Then click **Keep changes**.

Note 8

In [Figure 6-41](#), if you arrange the two boxes side by side, your extended desktop will extend left or right. If you arrange the two boxes one on top of the other, your extended desktop will extend up and down.

3. **3**

Adjust the screen resolution according to your preferences. The highest resolution is most often the best resolution for the monitor.

4. **4**

The Multiple displays setting allows you to select how to handle multiple displays. You can extend your desktop onto the second monitor, duplicate displays, or disable the display on either monitor. To save the settings, click **Keep changes**. The second monitor should initialize and show the extended or duplicated desktop.

5. **5**

Close the **Settings** app. For an extended desktop, open an application and verify that you can use the second monitor by dragging the application window 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 over the extended desktop. Switching from one monitor to the other does not require any special keystroke or menu option.

Most laptop computers are designed to be used with projectors and provide a VGA, DisplayPort, or HDMI port for this purpose. To use a projector, plug it in to the extra port, and then turn it on. For a laptop computer, use a function key to activate the video port and toggle between extending the desktop to the projector, using only the projector, duplicating the screen on the projector, or not using the projector. When giving a presentation, most people prefer to see it duplicated on the LCD screen and the projector.

Note 9

For group presentations that require a projector, the most common software used is Microsoft PowerPoint. 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 PowerPoint slides. To do so, select the **Slide Show** tab in PowerPoint. In the Set Up group, click **Set Up Slide Show**. In the Set Up Show box under Multiple monitors, check **Use Presenter View** and click **OK**.

6-5 Troubleshooting I/O Devices

Core 1 Objectives

- 1.2
Compare and contrast the display components of mobile devices.
- 3.4
Given a scenario, install and configure motherboards, central processing units (CPUs), and add-on cards.
- 5.4
Given a scenario, troubleshoot video, projector, and display issues.

A computer usually has so many types of peripheral devices that you'll probably troubleshoot at least one of each at some point in your technical career. When this happens, always try the least invasive and least expensive solutions first. For example, try updating drivers of a graphics tablet before replacing it. Now let's learn how to handle some of the errors or problems you might encounter.

6-5a NumLock Indicator Light

Core 1 Objective

- 5.4

Given a scenario, troubleshoot video, projector, and display issues.

If a user complains they cannot sign in to Windows even when they are certain they are entering the correct password, ask them to make sure the NumLock key is set correctly. Laptops use this key to toggle between the keys interpreted as letters and numbers. Most laptops have a NumLock indicator light near the keyboard.

6-5b Device Manager

Core 1 Objectives

- 3.4

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

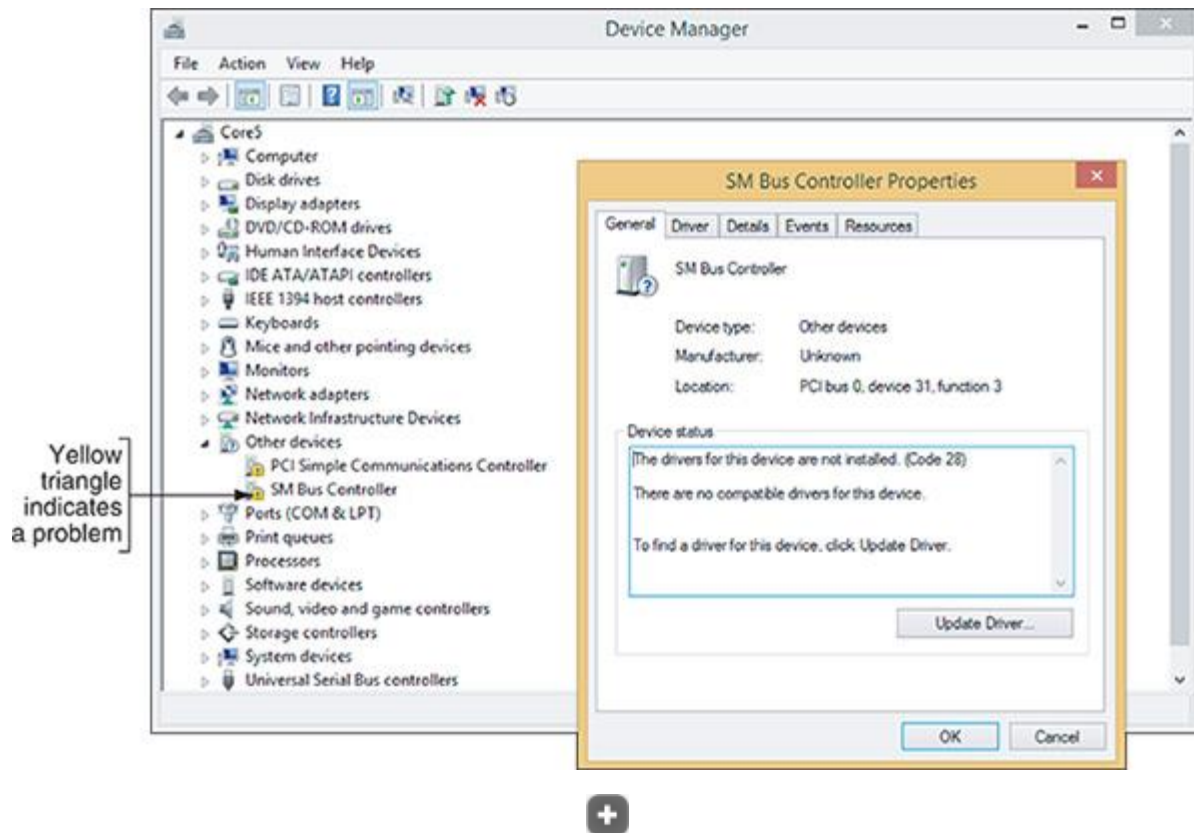
- 5.4

Given a scenario, troubleshoot video, projector, and display issues.

Device Manager is usually a good place to start troubleshooting. A Device Manager window is shown on the left side of [Figure 6-42](#). Click a white arrow to expand the view of an item and click a black arrow to collapse the view. Notice the yellow triangle beside the SM Bus Controller, which indicates a problem with this motherboard component. To see a device's properties dialog box, right-click the device and click **Properties**.

Figure 6-42

Use Device Manager to solve problems with hardware devices



First try updating the drivers. Click **Update Driver** on the General tab or the Driver tab. If a driver update creates a problem, you can roll back (undo) the update if the previous drivers were working. (Windows does not save drivers that were not working before the driver update.) If you are still having a problem with a device, try uninstalling it and installing it again. To uninstall the device, click **Uninstall** on the Driver tab. 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's needed to solve the problem.

If Windows is not able to locate new drivers for a device, locate and download the latest driver files from the manufacturer's website to your hard drive. For the SB Bus Controller, you would download the chipset drivers from the motherboard manufacturer's website. Be sure to use 64-bit drivers for a 64-bit OS and 32-bit drivers for a 32-bit OS. If possible, use Windows 10 drivers for Windows 10, and Windows 11 drivers for Windows 11. You can double-click the downloaded driver files to launch the installation.

Update Port or Slot Drivers on a Laptop

If you ever have a problem with a port or slot on a laptop, first turn to Device Manager to see if errors are reported and to update the drivers for the port or slot. The laptop manufacturer has probably stored backups of the drivers on the hard drive under support tools and on the recovery media if available. You can also download the latest drivers from the manufacturer's website. If

the problem is still not solved after updating the drivers, try using Device Manager to uninstall the port or slot drivers, and then use the support tools to reinstall the drivers.

Note 10

If a port or slot on a desktop or laptop fails even after updating the drivers, you can install an external device to replace the port or slot. For example, if the network port fails, you can purchase a USB to Ethernet adapter dongle to connect an Ethernet cable to the system using a USB port.

6-5c Audio Issues

Core 1 Objective

- 5.4

Given a scenario, troubleshoot video, projector, and display issues.

You're trying to play a video or listen to music, and you know sound should be coming out of the speakers, but they are quiet. When you're having audio issues, there are a few things you can try:

1. Make sure volume is turned up.
2. Check all audio cables, plugs, jacks, speakers, and headphone connections.
3. Update audio drivers.

Note 11

If you continue to struggle getting audio to play, the issue might not be with hardware. Microsoft offers some guidance to troubleshoot audio issues using Windows 10 tools here: support.microsoft.com/en-us/windows/fix-sound-problems-in-windows-10-73025246-b61c-40fb-671a-2535c7cd56c8.

6-5d Troubleshooting Video, Monitors, and Projectors

Core 1 Objective

- 5.4

Given a scenario, troubleshoot video, projector, and display issues.

For monitor and video problems, as with other devices, 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. Typical monitor and video

problems and how to troubleshoot them are described next. Then, you learn how to troubleshoot video problems on laptop computers.

Note 12

A user very much appreciates a 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.

Blurry Image

A fuzzy or blurry image on the screen can be quite frustrating and can strain your eyes if you stare at the screen for hours. Try these three steps when dealing with a blurry screen:

1. **1**
Clean the screen with an electronics-safe cleaning wipe or cloth.
2. **2**
Set your monitor resolution to its native or recommended resolution.
3. **3**
Check your cable connections. If you are using a VGA cable with an LCD monitor, it might create a blurry image. Upgrade to a digital connection using DVI, HDMI, or DisplayPort to optimize the video connection.

Problems with Video Card Installations

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

- **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.
- **When you first start up the system, you see nothing but a black screen.** This is most likely caused by the onboard video port not being disabled in BIOS/UEFI setup. Disable the port.
- **When you first start up the system, you hear a series of beeps.** BIOS/UEFI cannot detect a video card. Make sure the card is securely seated. The video slot or video card might be bad.
- **Error messages about video appear when Windows starts.** This can be caused by a conflict between onboard video and the video card. Try disabling onboard video in Device Manager.
- **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.

Monitor Indicator Light Is Not On; No Image on Screen

If you hear one or no beep during the boot and you see a blank screen, then BIOS/UEFI has successfully completed POST, which includes a test of the video card or onboard video. You can then assume the problem must be with the monitor or the monitor cable. Ask these questions and try these things:

1. Is the monitor power cable plugged in?
2. Is the monitor turned on? Try pushing the power button on the front of the monitor. An indicator light on the front of the monitor should turn on, indicating it has power.
3. Is the monitor cable plugged into the video port at the back of the computer and the connector on the rear of the monitor?
4. Try a different monitor and a different monitor cable that you know are working.

Note 13

When you turn on your computer, 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 website, for troubleshooting information about the card.

Monitor Indicator Light Is On; No Image on Screen

For this problem, try the following:

1. Make sure the video cable is securely connected at the computer and the monitor. The problem is most likely a bad cable connection.
2. Confirm that the video input source is set to the connector that you have the cable plugged into.
3. If the monitor displays POST but goes blank when Windows starts to load, the problem is Windows and not the monitor or video. Boot from the Windows setup DVD, and perform a Startup Repair, which you learned to do in the module [“Power Supplies and Troubleshooting Computer Problems.”](#) If this works, update the video drivers and verify the display resolution. Other tools for troubleshooting Windows are covered later in the text.
4. The monitor might have a switch on the back for choosing between 110 volts and 220 volts. Check that the switch is in the correct position.
5. The problem might be with the video card. If you have just installed the card and the motherboard has onboard video, go into BIOS/UEFI setup, and disable the video port on the motherboard.
6. Verify that the video cable is connected to the video port on the video card and not to a disabled onboard video port.
7. Using buttons on the front of the monitor, check the contrast adjustment. If there's no change, leave it at a middle setting.

8. Check the brightness or backlight adjustment. If there's no change, leave it at a middle setting.
9. 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.
10. As a test, use 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.
11. Open the computer case and reseal the video card. If possible, move the card to a different expansion slot. Clean the card's edge connectors using a contact cleaner purchased from a computer supply store.
12. 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.
13. 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.
14. Test the RAM on the motherboard with memory diagnostic software.
15. For a motherboard that is using a PCI Express video card, try using a PCI video card in a PCI slot or a PCIe ×1 video card in a PCIe ×1 slot. A good repair technician keeps an extra PCI video card around for this purpose.
16. Trade the motherboard for one you know is good. Sometimes, though rarely, a peripheral chip on the motherboard can cause the problem.

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 or projector can be configured to go into standby or sleep mode after a period of inactivity. Using this feature can also help prevent burn-in. **Burn-in** is when a static image stays on a monitor for many hours, leaving a permanent impression of that image on the monitor. An alternate method to avoid burn-in is to use a screen saver that has a moving image or a rotation of varying images. To wake up the computer, press any key on the keyboard, or press the power button. Use the Power Options applet in Control Panel to configure the sleep settings on a computer.

Problems might occur if the motherboard power-saving features or the Windows screen saver is 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.

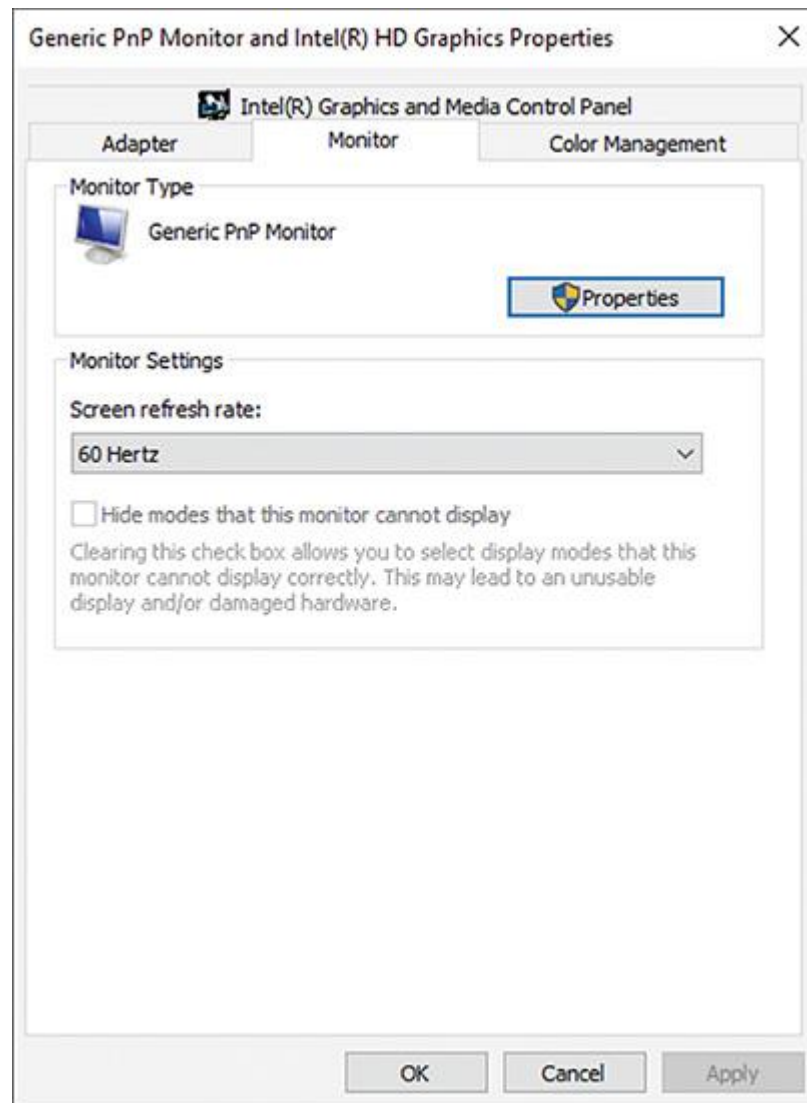
Poor Display

In general, you can solve problems with poor display by using controls on the monitor and using Windows settings. Do the following:

- **LCD monitor controls.** Use buttons on the front of an LCD monitor to adjust color, brightness, contrast, focus, and horizontal and vertical positions.
- **Windows display settings.** Use Windows settings to adjust font size, refresh rate, screen resolution, brightness, color, and ClearType text. To adjust display settings in Windows 10, right-click the desktop, and click **Display settings**. Here are a few settings:
 - **Resolution.** The resolution is the number of horizontal and vertical pixels used to build one screen. In the Resolution drop-down menu, select the highest resolution. If the monitor shows **distorted geometry** where images are stretched inappropriately, make sure the resolution is set to its highest value. Also, a low resolution can cause oversized images or icons.
 - **Refresh rate.** The refresh rate is the number of times the monitor refreshes the screen in 1 second. To adjust the refresh rate, click **Display adapter properties**. On the Monitor tab, select the highest screen refresh rate available (see [Figure 6-43](#)).

Figure 6-43

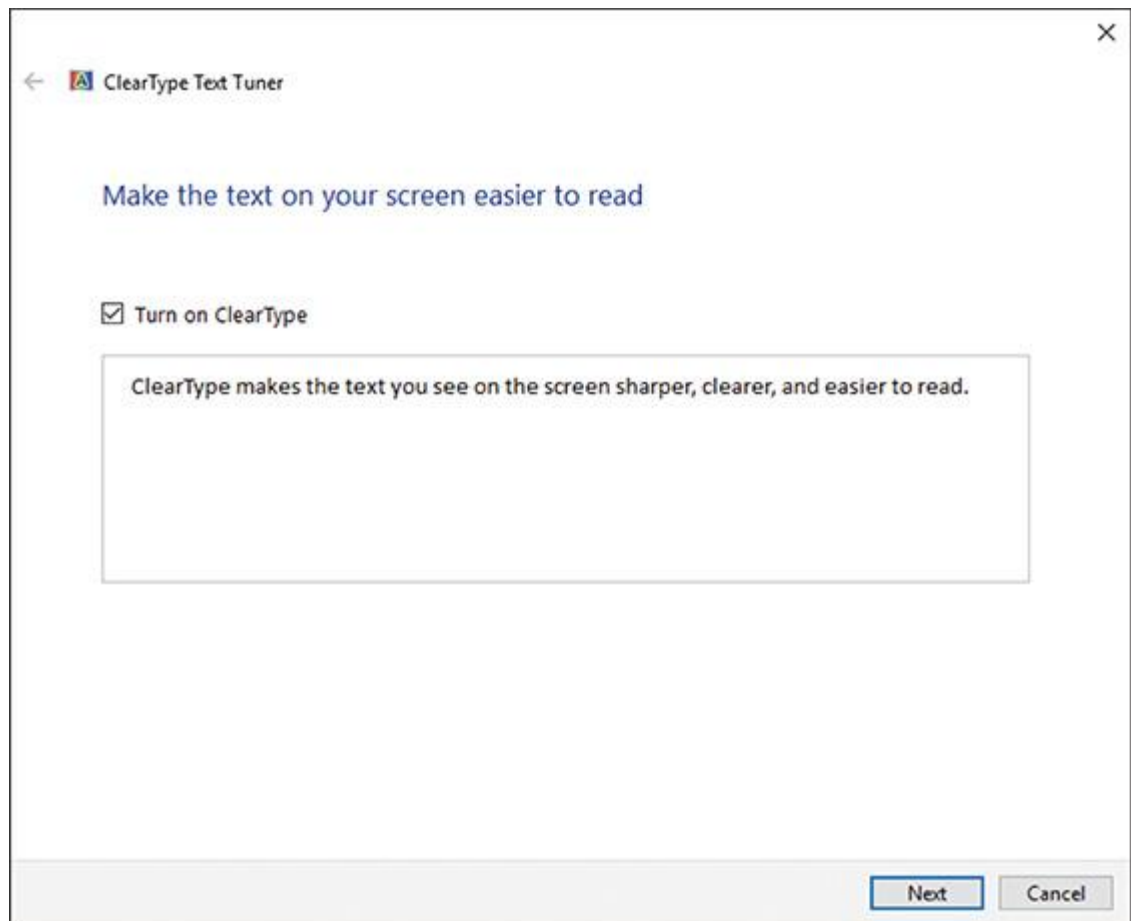
Use the highest refresh rate the system supports



- **ClearType.** In Windows 10, open the **Settings** app, and open the **System** group to find display settings. To open the ClearType Text Tuner, search on **ClearType** in the search box of the Settings app, select **Adjust ClearType text**, and check **Turn on ClearType** (see [Figure 6-44](#)). Then follow the steps in the wizard to improve the quality of text displayed on the screen.

Figure 6-44

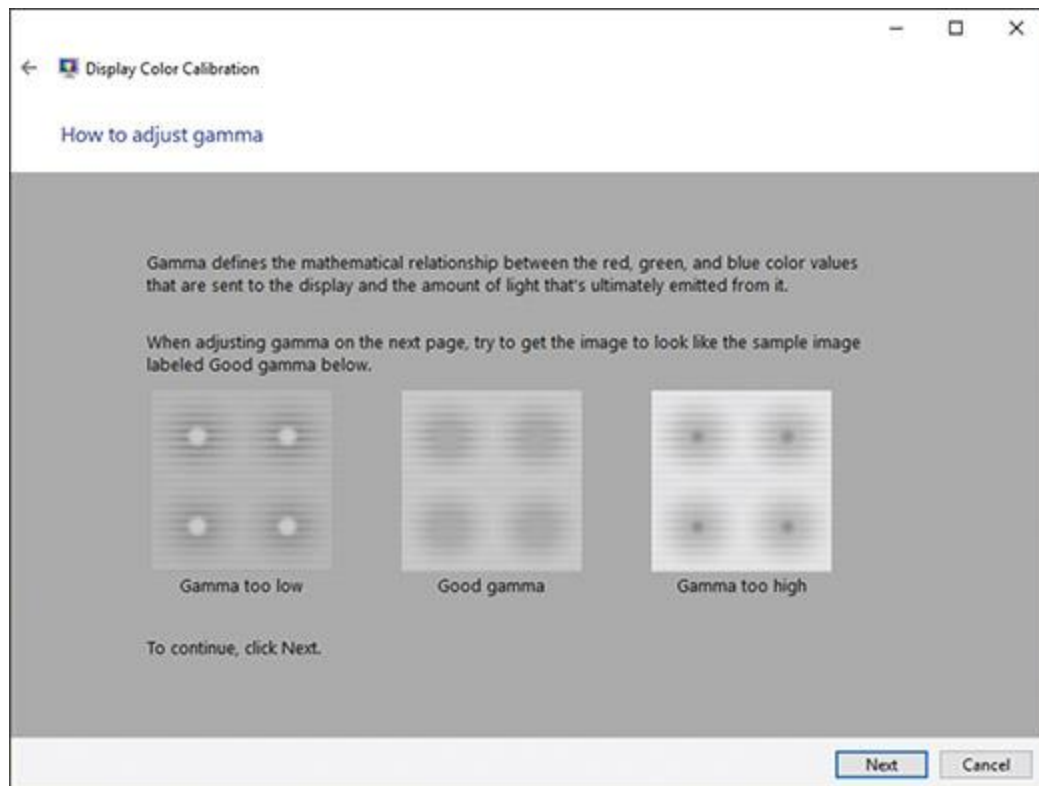
ClearType in Windows improves the display of text on the screen



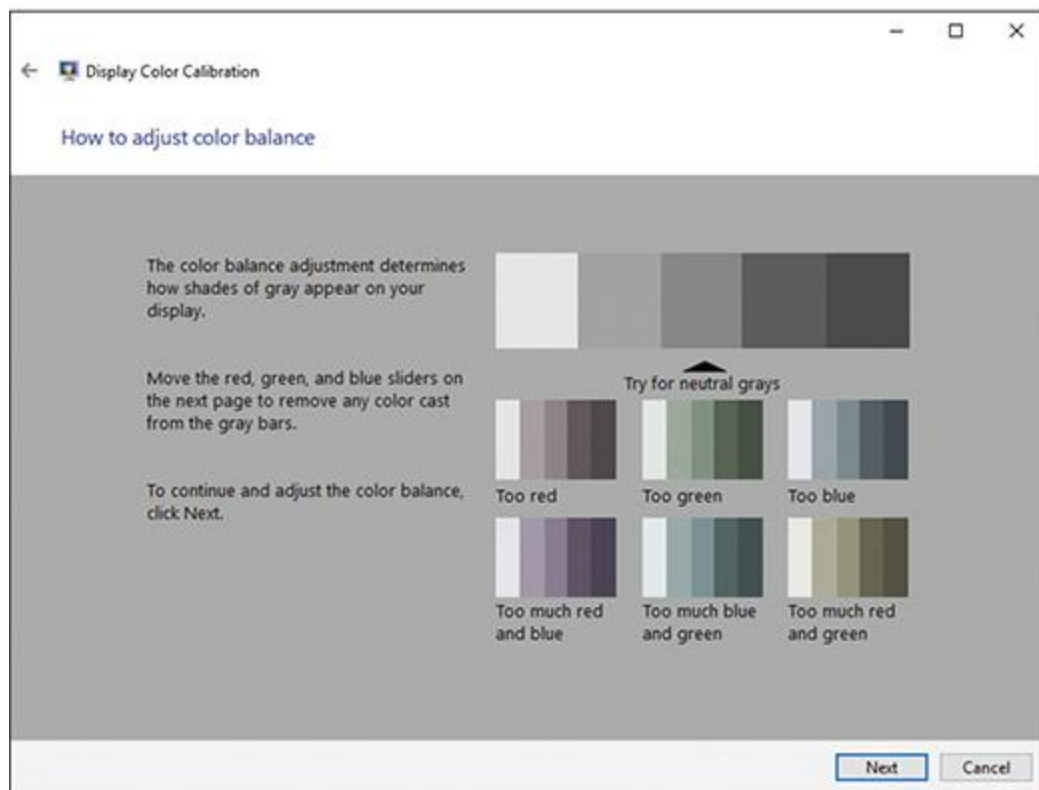
- **Color calibration.** If you have an incorrect color display, calibrate colors in Windows. First open the Settings app, search on **calibrate display color**, and follow the directions on-screen. As you do so, color patterns appear (see [Figure 6-45](#)). Use these screens to adjust the gamma settings, which define the relationships among red, green, and blue, as well as other settings that affect the display.

Figure 6-45

Two screens in the Windows 10 color calibration wizard



(A)



(B)

- **Update the video drivers.** The latest video drivers can often solve various problems with the video subsystem, including poor display.

Note 15

If adjusting the resolution doesn't correct distorted geometry or oversized images or icons, try updating the video drivers.

Here are a few other display problems and their solutions:

- **Dead pixels.** An LCD monitor might have pixels that are not working. These **dead pixels** can appear as small white, black, or colored spots on your screen. A black or white pixel is likely to be a broken transistor, which cannot be fixed. Having a few dead pixels on an LCD monitor screen is considered acceptable and usually is not covered under the manufacturer's warranty.

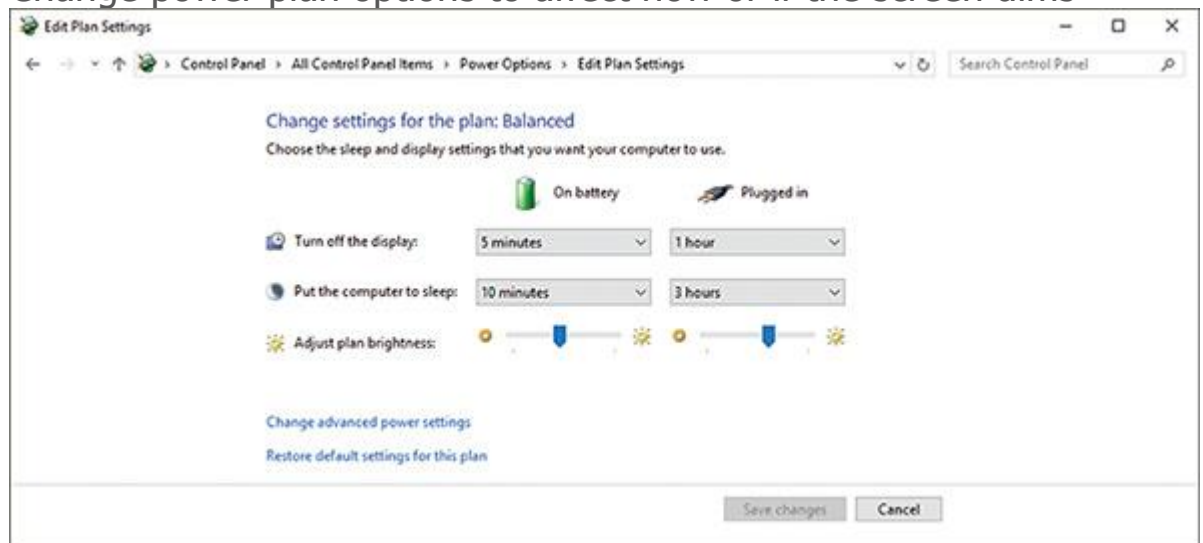
Note 16

A problematic pixel might not be a dead pixel (a hardware problem), but only a stuck pixel (a software problem). You might be able to use software to fix stuck pixels. For example, run the online software at jscreenfix.com to fix stuck pixels. The software works by rapidly changing all the pixels on the screen. (Be aware the screen flashes rapidly during the fix.)

- **Dim image.** A laptop computer dims the LCD screen when the computer is running on battery power to conserve the charge. You can brighten the screen by using the Windows display settings. In Windows 10, open the **Settings** app, click **System**, and then adjust the brightness slide bar (see [Figure 6-41](#)). To check whether settings to conserve power are affecting screen brightness, open **Control Panel** in Classic view, and click **Power Options**. Note the power plan that is selected. Click **Change plan settings** for this power plan. On the next screen, you can adjust when or if the screen will dim (see [Figure 6-46](#)). If the problem is still not resolved, it might be a hardware problem. How to troubleshoot hardware in laptops is covered later in this module.

Figure 6-46

Change power plan options to affect how or if the screen dims





A dim image in a desktop monitor might be caused by a faulty video card or a faulty monitor. To find out which is the problem, connect a different monitor. If the LCD monitor is the problem, most likely the backlighting is faulty and the monitor needs replacing.

Note 17

In this text, we've given several options for various freeware utilities. It's a good idea to know about your options for several reasons: Each freeware utility has different options, owners of freeware might not update their utilities in a timely manner, and websites might decide to include adware with their downloads.

In general, you can improve video quality by upgrading the video card and/or monitor. Poor display might be caused by inadequate video RAM. Your video card might allow you to install additional video RAM. See the card's documentation.

Cannot Connect to External Monitor or Projector

If the connection to the external monitor or projector fails when you're setting up dual monitors for a desktop, using a projector for a presentation, or connecting a monitor to a laptop to troubleshoot video problems with the laptop, try the following solutions:

1. Make sure the monitor or projector is getting power. Is the power cord securely connected? Is the electrical outlet working?
2. Check the connection at both ends of the video cable.
3. Is the monitor or projector turned on? For some projectors, a remote control is used to turn on the projector or wake it from sleep mode. The remote control batteries might be dead and need replacing.
4. Use the Function keys on a laptop to toggle between the laptop display and the external monitor or projector. (Alternately, you can press Windows key+P to toggle between displays.)
5. Try using a different video cable.
6. Try using a different video connection if the laptop and monitor have another option available.

If the projector shuts off unexpectedly, it might have entered sleep mode because of inactivity. Press the power button to wake the projector. If you can't wake it, the problem might be [overheat shutdown](#). Allow the 6-

5e Video System in a Laptop

Core 1 Objectives

- 1.2

Compare and contrast the display components of mobile devices.

- 5.4

Given a scenario, troubleshoot video, projector, and display issues.

If the LCD panel in a laptop shows a black screen but the power light indicates that power is getting to the system, the video subsystem might be the source of the problem. Do the following:

1. Look for an LCD cutoff switch or button on the laptop (see [Figure 6-47](#)). The switch must be on for the LCD panel to work.

Figure 6-47

The LCD cutoff button on a laptop



2. Try to use an onboard video port to connect an external monitor. After you connect the monitor, use a function key to toggle between the LCD panel, the external monitor, and both the panel and monitor. If the external monitor works but the LCD panel does not, use the external monitor to check Device Manager for warnings about the video controller and to update the video drivers.
3. If you still can't get the LCD panel to work but the external monitor does work, you have proven the problem is with the LCD panel assembly. In a laptop, a dim screen or no display can be caused by a bad inverter. Steps to replace the inverter board in a laptop are covered later in the module.

Flickering, Dim, or Otherwise Poor Video

Use these tips to solve problems with bad video:

- Verify Windows display settings. Try using the highest resolution for the LCD panel. This resolution will be the best available unless the wrong video drivers are installed.
- Try adjusting the brightness, which is a function of the backlight component of the LCD panel.
- Try updating the video drivers. Download the latest drivers from the laptop manufacturer's website. Bad drivers can cause an occasional ghost cursor on-screen. A **ghost cursor** is a trail left behind when you move the mouse.
- If the cursor drifts on the screen when the mouse or touch pad isn't being used, try using a different port on the computer or replacing the batteries in the mouse.
- A flickering or flashing screen can be caused by bad video drivers, a low refresh rate, a bad inverter, or loose connections inside the laptop. After setting the refresh rate to its highest setting, updating the video drivers, and checking for loose connections, try replacing the inverter.

Applying Concepts

Replace the Inverter Board in a Laptop

- **Est. Time:** 1 hour
- **Core 1 Objective:** 1.2

Because the LCD panel is so fragile, it is one component that is likely to be broken when a laptop is not handled properly. For a laptop that uses fluorescent backlighting, the problem might be the inverter if the screen is dim but some display is still present. The inverter board converts DC to the AC used to power the backlighting of the LCD panel (see [Figure 6-48](#)).

Figure 6-48

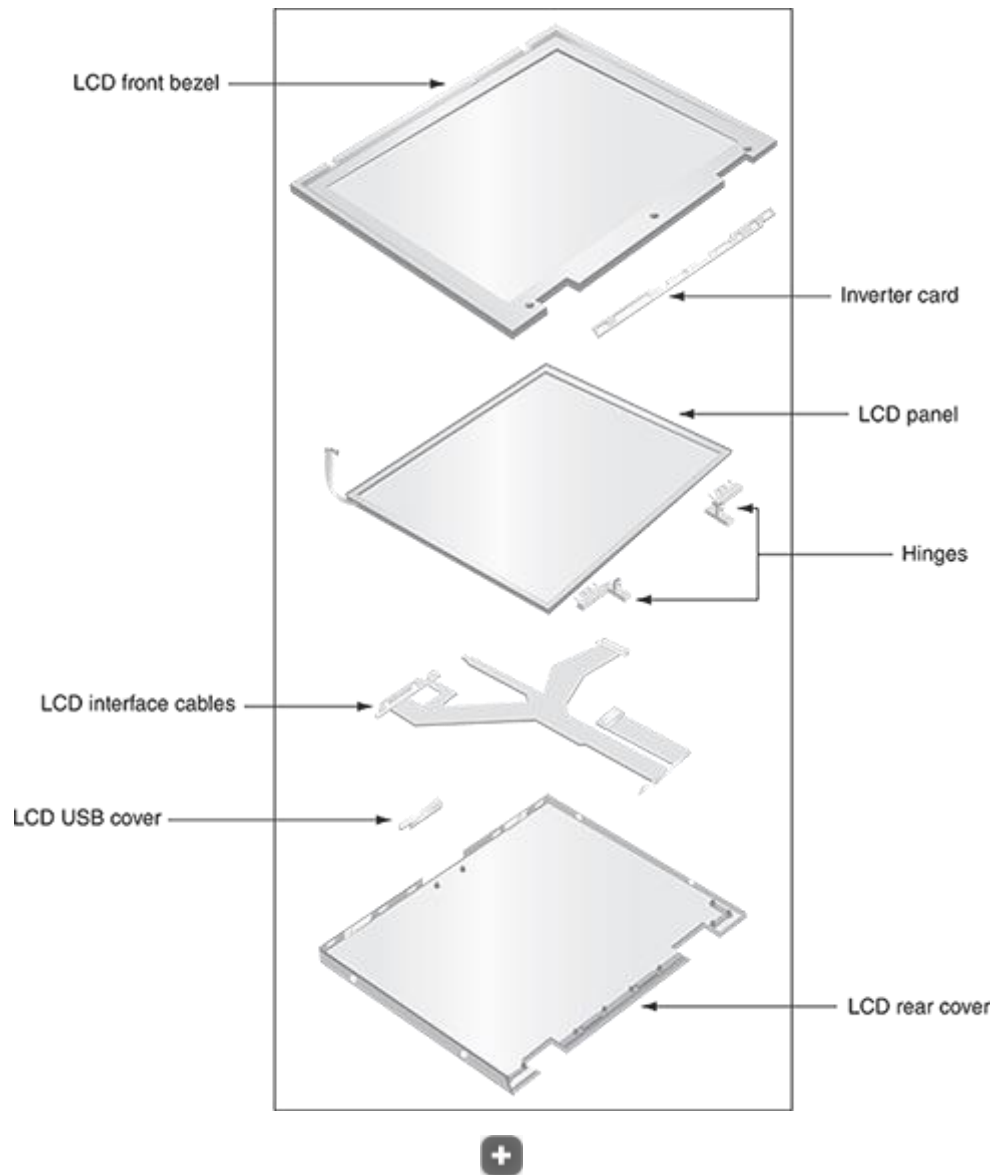
A ThinkPad inverter board



An LCD assembly might include a microphone, webcam, and speakers that are embedded in the laptop lid. For other laptops, the microphone and speakers are inside the case. In addition, a Wi-Fi antenna might be in the lid of the laptop, which is why you should raise the lid if you need a better Wi-Fi signal. To replace the inverter board, you will likely have to take apart the LCD assembly, as seen in [Figure 6-49](#).

Figure 6-49

Components in an LCD assembly



Before you begin any disassembly of a laptop, refer to the manufacturer documentation. The following are some general directions to replace an inverter board:

1. Remove the AC adapter and the battery pack.
2. Remove the upper keyboard bezel, which is the band around the keyboard that holds it in place. You might also need to remove the keyboard.
3. Remove the screws holding the hinge in place, and remove the hinge cover. [Figure 6-50](#) shows a laptop with a metal hinge cover, but some laptops use plastic covers that can easily break as you remove them. Be careful with the plastic ones.

Figure 6-50

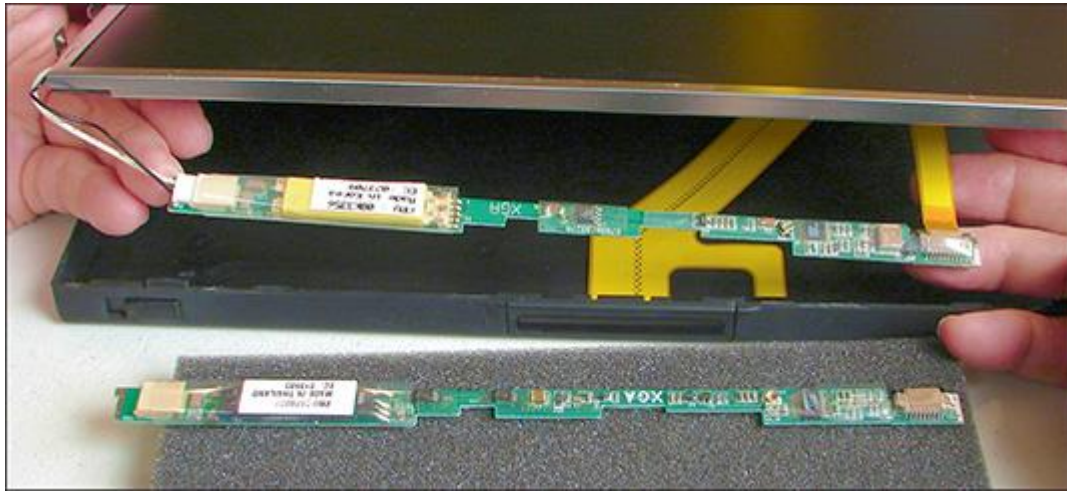
Remove the hinge cover from the laptop hinge



4. Remove the screws holding the LCD panel to the laptop.
5. You're now ready to remove the LCD panel from the laptop. Be aware there might be wires running through the hinge assembly, cables, or a pin connector. Cables might be connected to the motherboard using ZIF connectors. As you remove the LCD top cover, be careful to notice how the panel is connected. Don't pull on wires or cables as you remove the cover, but first carefully disconnect them.
6. Next, remove screws that hold the top cover and LCD panel together. Sometimes, these screws are covered with plastic or rubber circles or pads that match the color of the case. First use a dental pick or small screwdriver to pick off these covers. You should then be able to remove the front bezel and separate the rear cover from the LCD panel. A spudger can help separate the bezel from the case. For one LCD panel, you can see the inverter board when you separate the LCD assembly from the lid cover. [Figure 6-51](#) shows the inverter being compared with the new one to make sure they match. The match is not identical but should work.

Figure 6-51

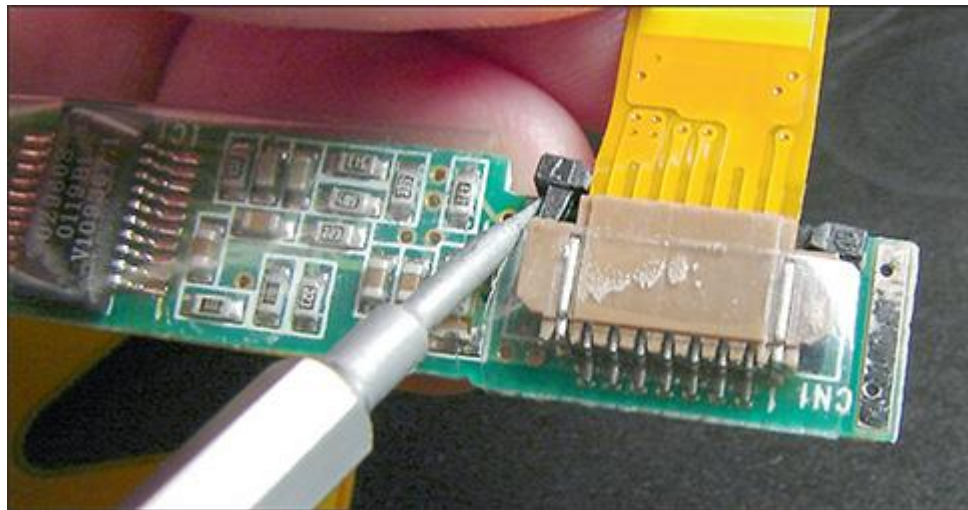
The inverter is exposed and is compared with the new one



7. Disconnect the old inverter, and install the new one. When disconnecting the ribbon cable from the old inverter, notice you must first lift up on the lock holding the ZIF connector in place, as shown in [Figure 6-52](#).

Figure 6-52

Lift up on the ZIF connector locking mechanism before removing the ribbon cable



8. Install the new inverter. Reassemble the LCD panel assembly. Make sure the assembly is put together with a tight fit so all screws line up well.
9. Reattach the LCD panel assembly to the laptop.
 7. projector lamp to cool down. Make sure the air vents are not obstructed and the room temperature is not too hot. The air filters inside the projector might be clogged with dust and need replacing.

6-6a **Module Summary**

Basic Principles for Supporting I/O Devices

- Adding new devices to a computer requires installing hardware and software. Even if you generally know how to install an I/O device, always follow the specific instructions of the product manufacturer.
- Use Device Manager in Windows to manage hardware devices and to solve problems with them.
- Wired data transmission types include USB, eSATA, Thunderbolt, and Lightning. Wireless data transmission types include Wi-Fi, Bluetooth, and NFC.
- USB connectors include the A-Male, Micro-A, B-Male, Mini-B, Micro-B, and USB-C.
- Popular I/O ports on a desktop or laptop motherboard include eSATA and USB. Older computers sometimes used serial RS-232 ports.
- Video ports that a video card or motherboard might provide are VGA, DVI-I, DVI-D, DisplayPort, HDMI, HDMI mini, and multipurpose Thunderbolt ports.
- Other peripheral connectors and ports include eSATA, Lightning, and RS-232.

Identifying and Installing I/O Peripheral Devices

- Peripheral devices you might be called on to install include keyboards, mice, touch pads, microphones, digitizers, webcams, and display devices.
- When installing devices, use 32-bit drivers for a 32-bit OS and 64-bit drivers for a 64-bit OS.

Installing and Configuring Adapter Cards

- Generally, when an adapter card is physically installed in a system and Windows starts up, it detects the card, and then you install the drivers using the Windows wizard. However, always follow specific instructions from the device manufacturer when installing an adapter card because the order of installing the card and drivers might be different.
- A sound card allows you to input audio and use multispeaker systems.
- A capture card allows you to record and stream content from an external device.

Supporting the Video Subsystem

- Types of monitors include LCD and OLED.
- Technologies and features of LCD monitors include screen size, refresh rate, pixel pitch, resolution, contrast ratio, viewing angle, backlighting, and connectors that a monitor uses.
- Use the Windows 10 Settings app to configure monitor resolution and to configure dual monitors.

Troubleshooting I/O Devices

- Remember to try simple things first when troubleshooting I/O devices.
- Use Device Manager to update drivers on I/O devices giving trouble.
- Video problems can be caused by the monitor, video cable, video card, onboard video, video drivers, or Windows display settings.
- A few dead pixels on an LCD monitor screen are considered acceptable by the manufacturer.

6-6c Thinking Critically

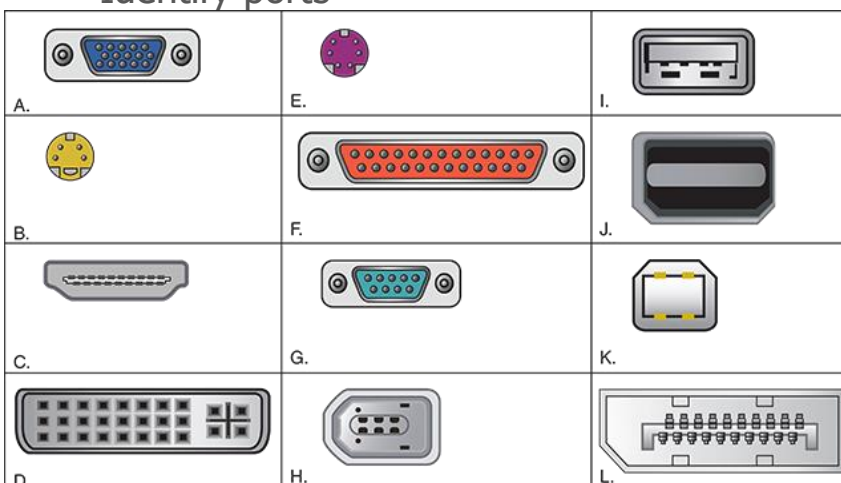
These questions are designed to prepare you for the critical thinking required for the A+ exams and may use information from other modules and the web.

1. You want to connect an external hard drive for backups. Which is the fastest connection used by current external hard drives? What is the speed?
2. You're working on a server in a server room and need to connect a keyboard. The port available has 9 pins. What type of port is this?
3. You have a contactless magnetic stripe and chip reader by Square. What type of wireless transmission does the device use to receive encrypted data?
4. Your manager bought a new printer with a USB 3.0 port, and it came with a USB 3.0 cable. Your manager asks you if the printer will work if they connect the printer's USB cable into a USB 2.0 port on their computer. What is your answer?
 1. No, the printer can only use a USB 3.0 port.
 2. Yes, it will work, but at the USB 2.0 speed.
 3. Yes, it will work at the USB 3.0 speed.
 4. Yes, it will work, but at the USB 1.1 speed.
5. What is the easiest way to tell if a USB port on a laptop computer is using the USB 3.0 standard?
6. Your friend Jin calls you asking for help with her new LCD monitor. She says the monitor isn't showing the whole picture. What is the display resolution you should recommend for her to use?
7. Your manager has asked you what type of monitor they should use in their new office, which has a wall of windows. They are concerned there will be considerable glare. Which gives less glare, an LCD monitor or an OLED monitor?
8. Which Windows utility is most likely the best one to use when uninstalling an expansion card?
9. Would you expect all the devices listed in BIOS/UEFI setup to also be listed in Device Manager? Would you expect all devices listed in Device Manager to also be listed in BIOS/UEFI setup?
10. Why is it best to leave a slot empty between two expansion cards?
11. You're connecting a single speaker to your computer. Which speaker port should you use?
12. What can you do if a port on the motherboard is faulty and a device requires this type of port?
13. Which type of drivers must always be certified in order to be installed in Windows?
14. Your desktop computer has DVI and HDMI video ports. If a DVI monitor does not work on your system but you know the monitor is good, what is the best solution?
 1. Use a DVI to HDMI adapter to use the current DVI monitor and cable.
 2. Buy a new HDMI monitor to use with the HDMI port.
 3. Install a video card in your computer with a DVI port.
 4. Replace the motherboard with another motherboard that has a DVI port.
15. You plug a new scanner into a USB port on your Windows system. When you first turn on the scanner, what should you expect to see?

1. A message is displayed by the scanner software telling you to reboot your system.
 2. Windows Device Setup launches to install drivers.
 3. Your system automatically reboots.
 4. An error message from the USB controller is displayed.
16. You turn on your Windows computer and see the system display POST messages. Then the screen goes blank with no text. Which of the following items could be the source of the problem?
1. The video card
 2. The monitor
 3. Windows
 4. Microsoft Word software installed on the system
17. You have just installed a new sound card in your system, and Windows says the card installed with no errors. When you plug in the speakers and try to play music, you hear no sound. What is the first thing you should do? The second thing?
1. Check Device Manager to see if the sound card is recognized and has no errors.
 2. Reinstall Windows.
 3. Use Device Manager to uninstall the sound card.
 4. Identify your sound card by opening the case and looking on the card for the manufacturer and model.
 5. Check the volume controls on the speaker amplifier and in Windows.
 6. Use Device Manager to update the sound card drivers.
18. You have just installed a new DVD drive and its drivers in Windows. The drive will read a CD but not a DVD. You decide to reinstall the device drivers. What is the first thing you do?
1. Open the Settings app and click the System group.
 2. Open Device Manager and choose Update Driver.
 3. Remove the data cable from the DVD drive so Windows will no longer recognize the drive and allow you to reinstall the drivers.
 4. Open Device Manager and uninstall the drive.
19. Match the following ports to the diagrams in [Figure 6-53](#): Dual Link DVI-I, USB Type A, USB Type B, VGA, DisplayPort, Mini DisplayPort, HDMI, and serial RS-232. (Note that some port diagrams are not used.)

Figure 6-53

Identify ports



Module 6 Review Quiz

1. Your boss bought a new printer with a USB 3.0 port, and it came with a USB 3.0 cable. Your boss asks you: Will the printer work when I connect the printer's USB cable into a USB 2.0 port on my computer?

Answer: Yes, but at the USB 2.0 speed.

2. Your desktop computer has DVI and HDMI video ports. If a DVI monitor does not work on your system and yet you know the monitor is good, what is the best solution?

Answer: Use a DVI to HDMI adapter to use with the current DVI monitor and cable.

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

Answer: Windows Device Manager launches to install drivers.

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

Answer: Windows

5. You have just installed a new sound card in your system, and Windows says the card installed with no errors. When you plug up the speakers and try to play a music CD, you hear no sound. What is the first thing you should do?

Answer: Check the volume controls on the speaker and in Windows.

6. You have just installed a new DVD drive and its drivers in Windows 10. The drive will read a CD but not a DVD. You decide to reinstall the device drivers. What is the first thing you do?

Answer: Open Device Manager and uninstall the drive

7. Your customer, Mykel, is ordering a custom-built computer for his home office and isn't sure which components should be the highest priority to meet his needs. He's a software developer and runs multiple VMs to test his applications. He also designs some of his own graphics, and he plays online games when he's not working. Which of the following priorities would be most important for Mykel's computer?

Answer: High-end CPU, lots of RAM, and high-end graphics card