Removable Media

"Bring my screwdriver and my special CD of town-saving music."

—JIMMY NEUTRON, *JIMMY NEUTRON: BOY GENIUS*

In this chapter, you will learn how to

- **Describe and install floppy disk drives**
- **Demonstrate the variations among flash drives and other tiny drives**
- **Identify and install optical-media technology**
- **Troubleshoot removable media**

Removable media refers to any type of mass storage device that you may use in one system and then physically remove from that system and use in another. Removable media has been a part of the PC since its introduction back in 1980. Back then, the only removable media available was floppy disks, but being able to move programs and data easily from one machine to another was quickly established as one of the strongest points of the PC. Over time, higher-capacity removable media technologies were introduced. Some technologies—CDs, DVDs, Blu-ray Discs, and thumb drives, for example—have become very common. Other technologies (which you may or may not have heard of), such as Iomega Zip drives or HD DVDs, were popular for a time but faded away or were discontinued. The history of PCs has also left a trash heap of removable media technologies that were trumpeted in with fanfare and a lot of money but never really saw any adoption.

Today's highly internetworked computers have reduced the need for removable media as a method of sharing programs and data, but removable media has so many other uses that it's still going strong. Removable media is the perfect tool for software distribution, data archiving, and system backup. Figure 13.1 shows my software toolbox. As a PC technician, you'll not only need to install, maintain, and troubleshoot removable media on systems for users, but also find yourself turning to removable media as a way to store and run software tools to perform all types of PC support (remember the live CDs in Chapter 12?).

This chapter covers the most common types of removable media used today and the forsaken floppy drive. For the sake of organization, the removable media types are broken down into these groups:

• **Figure 13.1**   Author's toolbox

- **Floppy drives**   The traditional floppy drive

- **Flash memory**   From USB thumb drives to flash memory cards

- **Optical discs**   Any shiny disc technology, from CD-ROMs and DVDs to Blu-ray Discs

- **External drives**   Any hard drive or optical drive that connects to a PC via an external cable

If you go by the earlier description of removable memory, two other technologies, PC Cards and tape backups, also fit as removable media. PC Cards are a laptop-centric technology and are covered in Chapter 26, whereas tape backups are part of the big world of backups and are covered in Chapter 17.

Historical/Conceptual

■ Floppy Drives

Good old floppies! These little disks, storing a whopping 1.44 MB of data per disk, were a part of PCs from the beginning and made it all the way to the first decade of the 21st century. For decades, the PC industry made one attempt after another to replace the floppy with some higher-capacity removable media, only to keep falling back to the floppy disk. Floppy drive technology was well entrenched: motherboard makers found floppies easy to add, all BIOS supported them, and they were almost always the first boot device, so techs loved floppies when they helped boot a system.

Over the past several years, floppy drives have disappeared from mass-produced PCs thanks to an industry push called *legacy-free computing*: an initiative forwarded by Microsoft and Intel back in 2001 to rid computers of old technologies such as PS/2 ports, serial ports, parallel ports—and

You might notice that I speak about floppy drives as if they don't exist anymore. That's because no one really uses them these days, and even if you wanted to, most modern motherboards don't have the required connections to install a floppy drive. But the CompTIA A+ exams want you to know about them on the off chance you run into one while hunkered down in an abandoned building during the apocalypse.

Floppy drive and floppy disk

The term "floppy" comes from the fact that early floppy disks were actually floppy. You could easily bend one. Newer floppy disks came in much more robust, rigid plastic casings, but the term has stuck—we still call them floppies.

• Figure 13.3   Floppy cable for only one drive

floppy drives (interesting how long it took to start being adopted by PC makers). Thus, the venerable floppy drive, without enough capacity to hold even a single MP3 or digital photo, died.

Floppy Drive Basics

When you insert a **floppy disk** into a **floppy drive**, the protective slide on the disk opens, revealing the magnetic media inside the plastic casing. A motor-driven spindle snaps into the center of the drive to make it spin. A set of read/write heads then moves back and forth across the disk, reading or writing tracks on the disk as needed. The 3½-inch-wide floppy disk arrived in 1987 and stored 1.44 MB (see Figure 13.2). You use a **3½-inch floppy drive** to access the contents of the disk.

Whenever a system accesses a floppy disk in its floppy drive, a read/write LED on the outside front of the drive flashes on. Don't try to remove the floppy disk from the drive when this light is lit! That light means that the read/write heads are accessing the floppy drive, so pulling the disk out while the light is on can damage the floppy disk. When the light is off, you can push in the small release button on the front of the drive to eject the floppy disk.

801

Installing Floppy Drives

All Windows systems reserve the drive letters A: and B: for floppy drives. You cannot name them anything other than A: or B:, but you can configure a floppy to get either drive letter. However, convention dictates that if you have only one floppy drive, you should call it A:. The second floppy drive is then called B:.

Floppy drives connect to the computer via a **34-pin ribbon cable**. If the cable supports two floppy drives, it has a seven-wire twist in the middle to differentiate electronically between the A: and B: drives. Given that the majority of users do not want two floppy drives (or one, for that matter), many system makers have dropped the twist and saved a couple of pennies on a simpler cable (see Figure 13.3).

By default, almost all PCs that still support floppy drives first try to boot to a floppy before any other boot device, looking for an operating system. This process enables technicians to insert a floppy disk into a sick computer to run
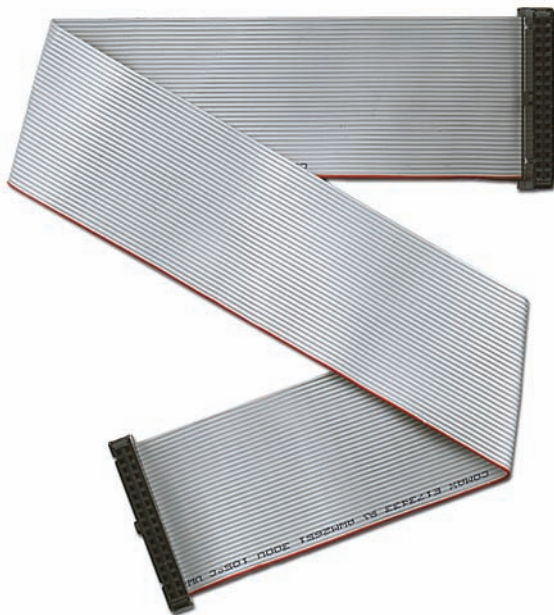
programs when the hard drives fail. It also means hackers can insert bootable floppy disks into servers and do bad things. You do have a choice, however, because most systems have special CMOS settings with which you can change this default boot order to something other than the default drive A: and then C:; I'll show you how in a minute.

Inserting Ribbon Cables

Look at the floppy cable in Figure 13.3. Notice the connector on the left side. This connector, identical to the other connector on the same cable, plugs into the floppy controller on the motherboard, as shown in Figure 13.4. Notice how clearly the motherboard has **pin 1** marked in Figure 13.4. Not all motherboards are so clear. Make sure to orient the cable so that the colored stripe on the side of the cable is aligned with pin 1.

Here are a few tips on cable orientation. (By the way, these rules work for all ribbon cables, not just floppy cables.) Ribbon cable connectors usually have a distinct orientation notch in the middle. If your cable connector has an orientation notch and the controller socket has a slot in which the orientation notch fits, your job is easy (see Figure 13.5).

Unfortunately, not all connectors use the orientation notch. Try looking in the motherboard book. All motherboard books provide a graphic of the motherboard showing the proper orientation position. Look at other ribbon cables on the motherboard. In almost all motherboards, all plugs orient the same way. Last of all, just guess! You will not destroy anything by inserting the cable backward. When you boot up, the floppy drive will not work. This is not a big deal; turn off the system and try again.

After you insert the floppy ribbon cable into the floppy controller, you need to insert the ribbon cable into the floppy drive. Watch out here! You still need to orient the cable by pin 1—all the rules of ribbon cable insertion apply here, too. Before you plug in the floppy ribbon cable to the floppy drive, you need to know which connector on the cable to use; it makes a big difference. The specific connector that you insert into the floppy drive determines its drive letter.

If the floppy drive is installed on the end connector, it becomes the A: drive; if the drive is installed on the middle connector, it is the B: drive (see Figure 13.6). If you're installing only one floppy, make sure you install it in the A: drive position.
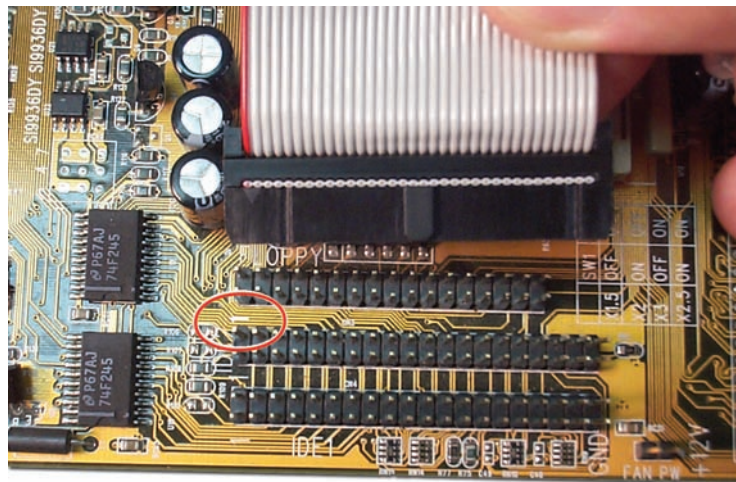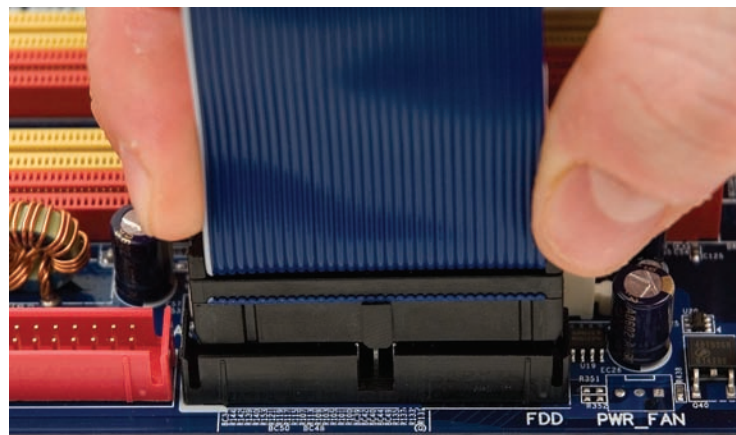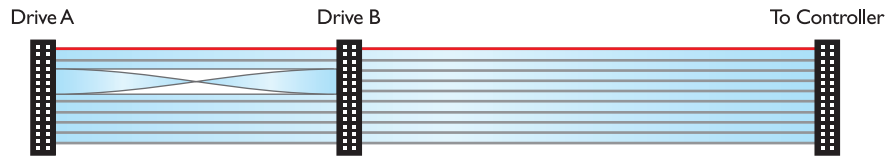

• Figure 13.5   Floppy controller with notch

In the past, the CompTIA A+ certification exams have been very focused on the pins on cables! Know the number (34) and orientation (pin 1 to pin 1) for the pins on the floppy drive ribbon cable.

Drive A   Drive B   To Controller
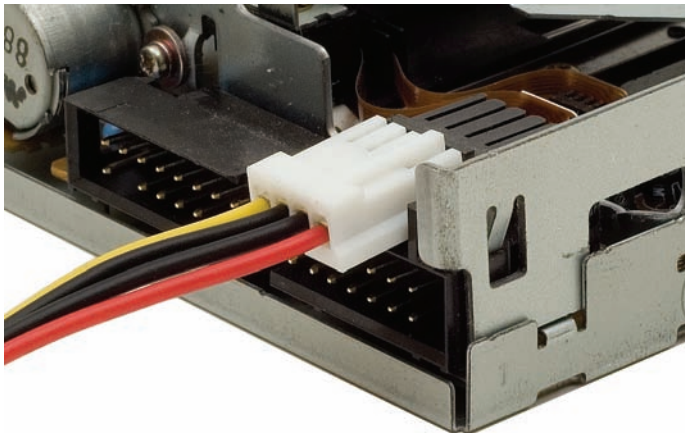
• Figure 13.6   Cable placement determines the drive letter.

Power

Floppy drives need electricity to work, just like every other device in the PC. Modern 3½-inch floppy drives use the small **mini power connector**. Be careful! Inserting a mini connector incorrectly is easy, and if you install it incorrectly, you'll destroy the floppy drive and make what we call "The Nasty Smell." Look at Figure 13.7, a bottom view of a properly installed mini power connector—note the chamfers (beveled edges) that show correct orientation. The problem lies in the plastic used to make the connector. The plastic connector bends easily, so even the least brawny techs can put the plug in a mini backward or hit only three of the four pins.

Great! You have installed a floppy drive! Once you have physically installed the floppy drive, it's time to go into CMOS.
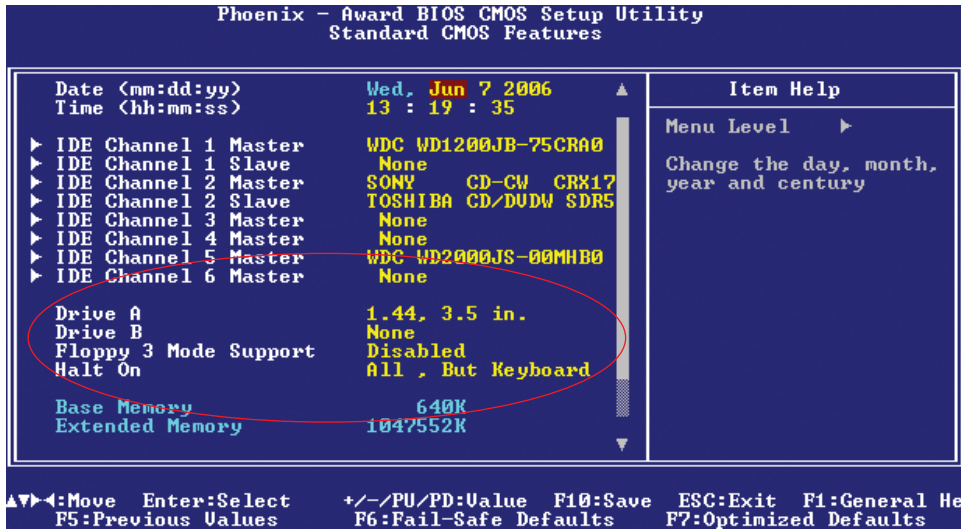
CMOS

After the floppy drive is installed, you need to configure the CMOS settings, which must correspond to the capacities of the drives. Look in your CMOS for a menu called "Standard CMOS Features" (or something similar to that) to see your floppy settings. Most CMOS setups configure the A: drive by default as a 3½-inch, 1.44-MB drive, so in most cases the floppy is already configured. Simply double-check the setting in CMOS; if it's okay, exit without changing anything. Figure 13.8 shows a typical CMOS setting for a single floppy drive. On the rare occasion that you require a setting other than the typical 3½-inch, 1.44-MB A: drive, simply select the drive (A: or B:) and enter the correct capacity.

Disabling the Boot Up Floppy Seek option tells the PC not to check the floppy disk during the POST, which isn't very handy except for slightly speeding up the boot process (see Figure 13.9).

Many CMOS setup utilities have an option called Floppy 3 Mode Support. Refer to Figure 13.8 to see an example of a CMOS with this option. A Mode 3 floppy is a special 1.2-MB format used outside the United States, primarily in Japan. Unless you live in Japan and use Mode 3 floppy disks, ignore this option.

• Figure 13.7   Properly installed mini power connector

```
                    Phoenix - Award BIOS CMOS Setup Utility
                           Standard CMOS Features

      Date (mm:dd:yy)            Wed, Jun 7 2006        ▲        Item Help
      Time (hh:mm:ss)            13 : 19 : 35
                                                          Menu Level    ▶
   ▶  IDE Channel 1 Master       WDC WD1200JB-75CRA0
   ▶  IDE Channel 1 Slave          None                   Change the day, month,
   ▶  IDE Channel 2 Master       SONY      CD-CW  CRX17    year and century
   ▶  IDE Channel 2 Slave        TOSHIBA CD/DVDW SDR5
   ▶  IDE Channel 3 Master         None
   ▶  IDE Channel 4 Master         None
   ▶  IDE Channel 5 Master       WDC WD2000JS-00MHB0
   ▶  IDE Channel 6 Master         None

      Drive A                    1.44, 3.5 in.
      Drive B                    None
      Floppy 3 Mode Support      Disabled
      Halt On                    All , But Keyboard

      Base Memory                    640K
      Extended Memory            1047552K                 ▼

   ▲▼▶◀:Move   Enter:Select   +/-/PU/PD:Value  F10:Save   ESC:Exit   F1:General He
      F5:Previous Values       F6:Fail-Safe Defaults      F7:Optimized Defaults
```

• Figure 13.8   CMOS setting for one standard floppy drive

```
                    Phoenix - Award BIOS CMOS Setup Utility
                           Advanced BIOS Features

      Quick Power On Self Test   Enabled                 Item Help
   ▶  Hard Disk Boot Priority    Press Enter
      First Boot Device          Floppy                 Menu Level    ▶
      Second Boot Device         Hard Disk
      Third Boot Device          CDROM                  Select User Define,AMD
      Boot Other Device          Enabled                K8 Cool 'n' Quite
      Boot Up Floppy Seek        Disabled               Function will Disable
      Boot up NumLock Status     On
      Security Option            Setup
      MPS Version Control For OS  1.4
      Delay For HDD (Secs)         0
      Full Screen LOGO Show      Disabled




   ▲▼▶◀:Move   Enter:Select   +/-/PU/PD:Value  F10:Save   ESC:Exit   F1:General Help
      F5:Previous Values       F6:Fail-Safe Defaults      F7:Optimized Defaults
```

• Figure 13.9   CMOS Boot Up Floppy Seek option

■ Flash Memory

Flash memory, the same flash memory that replaced CMOS technology for your system BIOS, found another home in PCs in the form of removable mass storage devices. Flash memory comes in two families: USB thumb drives and memory cards. USB thumb drives are flash devices that contain a standard USB connection. "Memory card" is a generic term for a number of tiny cards that are used in cameras, smartphones, and other devices. Both of these families can manifest themselves as drives in Windows, but they usually perform different jobs. USB thumb drives have replaced virtually all other rewritable removable media as the way people transfer files or keep copies of important programs. My thumb drives (yes, I have two on me at all times) keep backups of my current work, important photos, and a

stack of utilities I need to fix computers. Memory cards are very small and make a great way to store data on small devices and then transfer that data to your PC.

USB Thumb Drives

Moving data between computers is always a pain, but USB flash memory drives, also known as **USB thumb drives**, jump drives, and flash drives, are an incredibly popular solution (see Figure 13.10). For a low price, you can get a 32-GB thumb drive that holds as much data as 22,000 standard 3½-inch floppy disks.

The smallest thumb drives are slightly larger than an adult thumbnail; others are larger and more rounded. The drives are hot-swappable in all modern editions of Windows. You simply plug one into any USB port and it appears as a removable storage device in My Computer or Computer. After you plug the drive into a USB port, you can copy or move data to or from your hard disk and then unplug the unit and take it with you. You can read, write, and delete files directly from the drive. Because these are USB devices, they don't need an external power source. The nonvolatile flash memory is solid-state, so it's shock resistant and is supposed to retain data safely for a decade.

The latest systems enable you to boot to a thumb drive. With a bootable thumb drive, you can replace bootable floppies, CDs, and DVDs with fast flash drives. Making a thumb drive bootable is a bit of a challenge, so most of the classic bootable-utility CD makers have created USB versions that seek out your thumb drive and add an operating system with the utilities you wish to use. Most of these are simply versions of Linux-based live CDs. If you want to try it, check out GParted Live at http://gparted.sourceforge.net and click on the Live CD/USB link.

• Figure 13.10   USB thumb drives

Remember to change the boot order in CMOS when you want to boot from a USB flash drive. If you use the wrong boot order, your BIOS will skip straight to your hard drive and load your OS.

Flash Cards

Flash cards are the way people store data on small appliances. Digital cameras, smartphones, and MP3 players often come with slots for some type of memory card. Memory cards come in a number of incompatible formats, so let's start by making sure you know the more common ones.

CompactFlash

CompactFlash (CF) is the oldest, most complex, and physically largest of all removable flash media cards (see Figure 13.11). Roughly one inch wide, CF cards use a simplified PCMCIA bus (see Chapter 26 for details) for interconnection. CF cards come in two sizes: CF I (3.3 mm thick) and CF II (5 mm thick). CF II cards are too thick to fit into CF I slots.

Clever manufacturers have repurposed the CF form factor to create the microdrive (see Figure 13.12). **Microdrives** are true hard drives, using

• Figure 13.11   CF card

platters and read/write heads that fit into the tiny CF form factor. Micro-drives are slower and use more power than flash drives and, when they were first introduced, cost much less than an equivalent CF flash card. From the user's standpoint, CF flash cards and microdrives look and act exactly the same way, although the greater power consumption of microdrives makes them incompatible with some devices. These days, microdrives have been surpassed in size, speed, and cost by their flash cousins and have become more difficult to find.

SmartMedia

SmartMedia came out as a competitor to CF cards and for a few years was quite popular in digital cameras (see Figure 13.13). The introduction of SD media reduced SmartMedia's popularity, and no new devices use this media.

Secure Digital

Secure Digital (SD) cards are arguably the most common flash media format today. About the size of a small postage stamp, you'll see SD cards in just about any type of device that uses flash media.

SD cards come in two smaller forms called *Mini Secure Digital* (*MiniSD*) cards and *Micro Secure Digital* (*MicroSD*) cards. They're extremely popular in cellular phones that use flash memory, but they see little use in other devices. Figure 13.14 shows the three forms of SD cards.

SD cards come in three storage capacities. *Standard SD* cards store from 4 MB to 4 GB, *Secure Digital High Capacity* (*SDHC*) cards store 4 GB to 32 GB, and *Secure Digital Extended Capacity* (*SDXC*) cards have a storage capacity of 32 GB to 2 TB. Early SD card readers and devices cannot read the SDHC or SDXC cards, though the latter standards provide backward compatibility.

Memory Stick

Sony always likes to use proprietary formats, and their **Memory Stick** flash memory is no exception. If you own something from Sony and it uses flash memory, you'll need a Memory Stick, though not all Memory Sticks are manufactured by Sony (see Figure 13.15). There are several Memory Stick formats, including Standard, Pro, Duo, Pro Duo, and Micro.

• Figure 13.12   Microdrive

• Figure 13.13   SmartMedia

SD cards developed out of an older, slower flash memory technology called *MultiMediaCard* (*MMC*). If you happen to have an MMC card lying around, you can use it in almost any SD card slot. SD cards are a little thicker than MMC cards, though, so the reverse is not true.

• Figure 13.14   SD, MiniSD, and MicroSD cards

● **Figure 13.15**   Memory Stick

● **Figure 13.16**   xD card

xD Picture Card

The proprietary **Extreme Digital (xD) Picture Cards** (see Figure 13.16) are about half the size of an SD card. They're almost exclusively used in Olympus and Fujifilm digital cameras, although Olympus (the developer of the xD technology) produces a USB housing so you can use an xD Picture Card like any other USB flash memory drive. The xD Picture Cards come in three flavors: original, Standard (Type M), and Hi-Speed (Type H). The Standard cards are slower than the original cards but offer greater storage capacity. The Hi-Speed cards are two to three times faster than the others and enable you to capture full-motion video—assuming the camera has that capability, naturally!

Card Readers

Whichever type of flash memory you use, your PC must have a **card reader** to access the data on the card directly. A number of inexpensive USB card readers are available today (see Figure 13.17), and some PCs come with built-in readers—handy to have when someone pulls out an SD card and says "Let's look at the pictures I just took!" Of course, if the person just happened to bring her camera and USB cable along, you could connect the camera to the PC and pull pictures in that way. Just make sure you have spare batteries, too! Wouldn't a card reader be a more elegant solution?

Whichever type of flash memory you have, understand that it acts exactly like a hard drive. If you wish, you can format a memory card and copy, paste, and rename files.

● **Figure 13.17**   USB card reader

■ Optical Drives

CD, DVD, and Blu-ray Disc drives and discs come in a variety of flavors and formats, enabling you to back up data, record music, master home videos, and much, much more. **Optical disc** is the generic term for all those different types of shiny, 12-centimeter-wide discs that, if you're a slob like me, collect around your computer like pizza boxes. The drives that support them are called **optical drives**. This section examines optical discs, finishing with the details about installing optical drives.

CD stands for **compact disc**, a medium that was originally designed more than 25 years ago as a replacement for vinyl records. The **digital versatile disc (DVD)** first eliminated VHS cassette tapes from the commercial home movie market, and has also grown into a contender for backups and high-capacity storage. **Blu-ray Disc (BD)** eliminated the High-Definition DVD (HD DVD) format to become the only high-definition and high-capacity optical format.

Going beyond those big three household names, the term "optical disc" refers to technologies such as CD-ROM, CD-R, CD-RW, DVD, DVD+RW, HD DVD, BD-R, BD-RE, and so on. Each of these technologies will be discussed in detail in this chapter—for now, understand that although "optical disc" describes a variety of exciting formats, they all basically boil down to the same physical object: that little shiny disc.

CD-Media

The best way to understand the world of optical discs is to sort out the many types of technologies available, starting with the first: the compact disc. All you're about to read is relevant and fair game for the CompTIA A+ certification exams. Let's begin by looking at how CDs work.

How CDs Work

CDs—the discs that you buy in music stores or may find in software boxes—store data via microscopic pits. CD producers use a power laser to burn these pits into a glass master CD. Once the CD producer creates a master, expensive machines create plastic copies, using a very high-tolerance injection molding process. The copies are coated with a reflective metallic covering and then finished with lacquer for protection. CDs store data on only one side of the disc—we don't flip a CD as we used to flip vinyl records. Did I just sound really old? The data on a CD is near the top of the CD, where the label is located (see Figure 13.18).

Label side
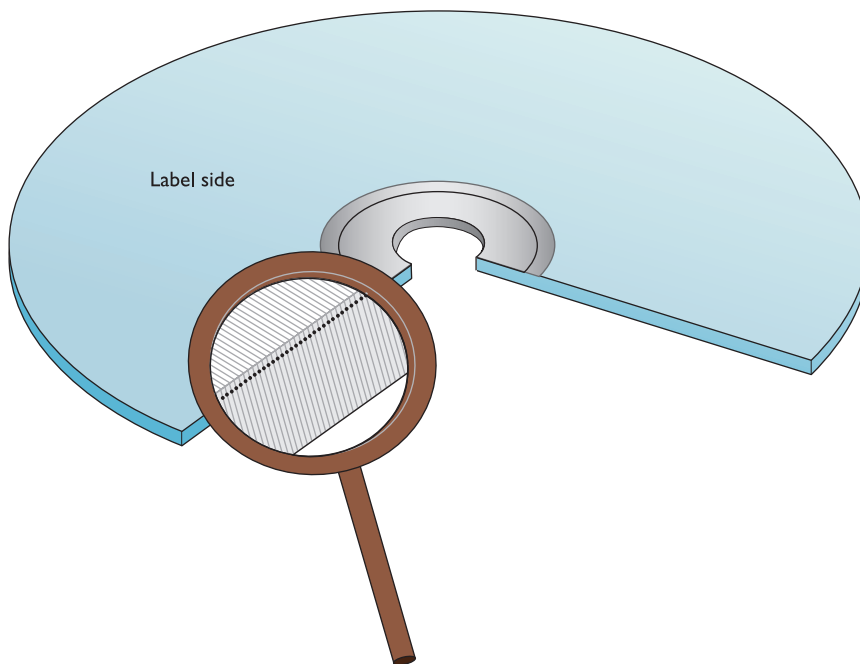
• **Figure 13.18**   Location of the data

Many people believe that scratching a CD on the bottom makes it unreadable. This is untrue. If you scratch a CD on the bottom (the shiny side), just polish out the scratches—assuming that they aren't too deep—and reread the CD. A number of companies sell inexpensive CD-polishing kits. It's the scratches on the *top* of the disc that wreak havoc on CDs. Avoid writing on the top with anything other than a soft-tipped pen, and certainly don't scratch the top!

CD readers (such as the one in your car or the one in your PC) use a laser and mirrors to read the data from the CD. The metallic covering of the CD makes a highly reflective surface; the pits create interruptions in that surface, while the non-pitted spots, called *lands*, leave it intact. The laser picks up on the reflected pattern that the pits and lands create, and the CD drive converts this pattern into binary ones and zeros. Because the pits are so densely packed on the CD, a vast amount of data can be stored: a standard CD holds up to 5.2 billion bits, or 650 million bytes, of data.

CD Formats

The first CDs were designed for playing music and organized the music in a special format called **CD-Digital Audio (CDDA)**, which we usually just call CD-audio. CD-audio divides the CD's data into variable-length tracks; on music CDs, each song gets one track. CD-audio is an excellent way to store music, but it lacks any error checking, file support, or directory structure, making it a terrible way to store data. For this reason, The Powers That Be created a special method for storing data on a CD, called—are you ready—**CD-ROM**. The CD-ROM format divides the CD into fixed sectors, each holding 2353 bytes.

Most CD-ROM drives also support a number of older, less well-known formats. You may never come across these formats—CD Text, CD+G, and so forth—although you may see them listed among compatible formats on the packaging for a new drive or with a program like Nero InfoTool (see Figure 13.19). Don't let these oddball formats throw you—with few exceptions, they've pretty much fallen by the wayside. All CD-ROM drives read all of these formats, assuming that the system is loaded with the proper software.

The CD-ROM format is something like a partition in the hard drive world. CD-ROM may define the sectors (and some other information), but it doesn't enable a CD-ROM disc to act like a hard drive, with a file structure, directories, and such. To make a CD-ROM act like a hard drive, there's another layer of formatting that defines the file system used on the drive.

At first glance you might think "Why don't CD-ROMs just use a FAT or an NTFS format like hard drives?" Well, first of all, they could. There's no law of physics that prevented the CD-ROM world from adopting any

Try This!

Repairing a CD-ROM

To revive scratched CD-ROMs and other CD-media in the comfort of your home or office, get a CD polishing kit, familiarize yourself with its operation, and then Try This!

1. Take a CD-ROM *that you don't mind potentially ruining* and make light scratches on the bottom of the disc. Be sure not to scratch too heavily! Just try to replicate the everyday wear and tear that you've probably seen on CD-ROMs. If you have a disc that's already lightly scratched, that's even better.

2. Use the CD-polishing kit, following the provided instructions exactly.

file system. The problem is that the CD makers did not want CD-ROM to be tied to Microsoft's or Apple's or anyone else's file format. In addition, they wanted non-PC devices to read CDs, so they invented their own file system just for CD-ROMs called **ISO-9660**. This format is sometimes referred by the more generic term, **CD File System (CDFS)**. The vast majority of data CD-ROMs today use this format.
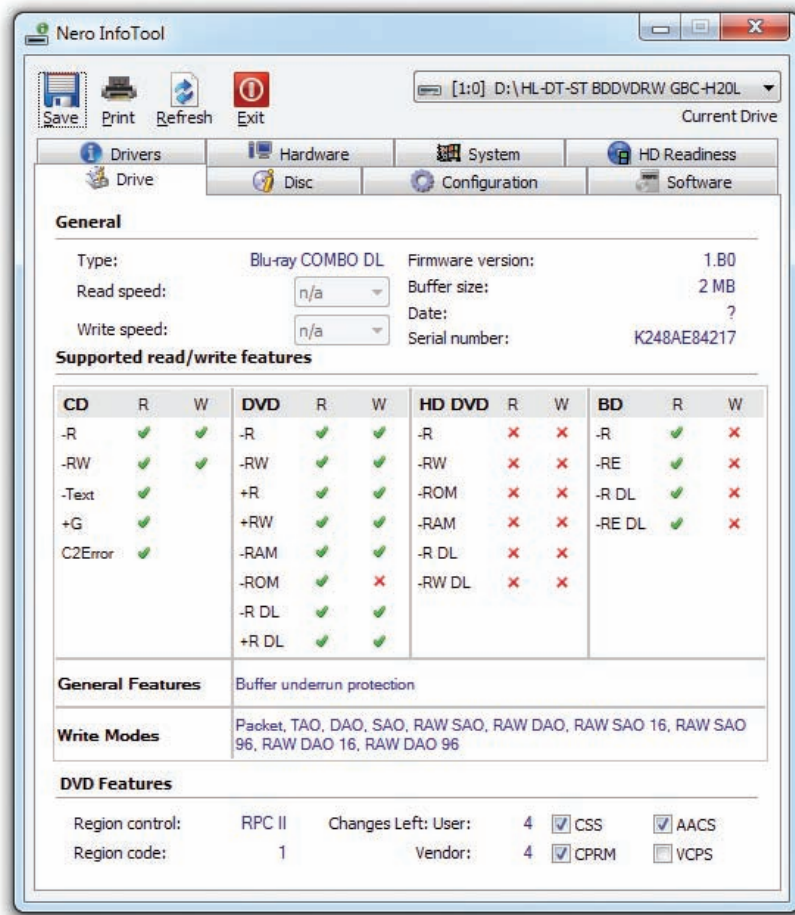
Over the years, extensions of the ISO-9660 have addressed certain limitations, such as the characters used in file and directory names, filename length, and directory depth.

CD-ROM Speeds

The first CD-ROM drives processed data at roughly 150,000 bytes per second (150 KBps), copying the speed from the original CD-audio format. Although this speed is excellent for listening to music, the CD-ROM industry quickly recognized that installing programs or transferring files from a CD-ROM at 150 KBps was the electronic equivalent of watching paint dry. Since the day the first CD-ROM drives for PCs hit the market, there has been a desire to speed them up to increase their data throughput. Each increase in speed is measured in multiples of the original 150-KBps drives and given an × to show speed relative to the first (1×) drives. Here's a list of the common CD-ROM speeds, including most of the early speeds that are no longer produced:

• Figure 13.19   Crazy CD formats

1× 150 KBps	10× 1500 KBps	40× 6000 KBps
2× 300 KBps	12× 1800 KBps	48× 7200 KBps
3× 450 KBps	16× 2400 KBps	52× 7800 KBps
4× 600 KBps	24× 3600 KBps	60× 9000 KBps
6× 900 KBps	32× 4800 KBps	72× 10800 KBps
8× 1200 KBps	36× 5400 KBps	

Keep in mind that these are maximum speeds that are rarely met in real-life operation. You can, however, count on a 32× drive to read data faster than an 8× drive. As multipliers continue to increase, so many other factors come into play that telling the difference between a 48× drive and a 52× drive, for example, becomes difficult. High-speed CD-ROM drives are so inexpensive, however, that most folks buy the fastest drive possible—at least installations go faster!

A CD-R disc, with its capacity clearly labeled

CD-R

Making CD-ROMs requires specialized, expensive equipment and substantial expertise, so a relatively small number of CD-ROM production companies do it. Yet, since the day the first CD-ROMs came to market, demand has been terrific for a way that ordinary PC users could make their own CDs. The CD industry made a number of attempts to create a technology that would let users record, or *burn*, their own CDs.

In the mid-1990s, the CD industry introduced the **CD-recordable (CD-R)** standard, which enables affordable CD-R drives, often referred to as *CD burners*, to add data to special CD-R discs. Any CD-ROM drive can then read the data stored on the CD-R, and all CD-R drives can read regular CD-ROMs. CD-R discs come in two varieties: a 74-minute disc that holds approximately 650 MB, and an 80-minute variety that holds approximately 700 MB (see Figure 13.20). A CD-R burner must be specifically designed to support the longer, 80-minute CD-R format, but most drives you'll encounter can do this.

CD-R discs function similarly to regular CD-ROMs, although the chemicals used to make them produce a brightly colored recording side on almost all CD-R discs. CD-ROM discs, in contrast, have a silver recording side. CD-R technology records data by using special organic dyes embedded into the disc. This dye is what gives the CD-R its distinctive bottom color. CD-R burners have a second burn laser, roughly ten times as powerful as the read laser, that heats the organic dye. This causes a change in the reflectivity of the surface, creating the functional equivalent of a CD-ROM's pits.

Once the CD-R drive burns data onto a CD-R, the data cannot be erased or changed short of destroying the disc itself. Early CD-R drives required that the entire disc be burned in one burn session, wasting any unused part of the CD-R disc. These were called single-session drives. All modern CD-R drives are **multisession drives**, so you can go back and burn additional data onto the CD-R disc until the disc is full. Multisession drives also have the capability to "close" a partially filled CD-R so that no more data can be burned onto that disc.

CD-R drives have two speeds that matter: the record speed and the read speed, both expressed as multiples of the 150-KBps speed of the original CD-ROM drives. The record speed, which is listed first, is always equal to or slower than the read speed. For example, a CD-R drive with a specification of 8×24× would burn at 8× and read at 24×.

CD-RW

For all their usefulness, CD-R drives have disappeared from the market. Notice that I didn't say CD-R *discs* have disappeared. Just as CD-R drives could both burn CD-R discs and read CD-ROMs, a newer type of drive called **CD-rewritable (CD-RW)** took over the burning market from CD-R drives. Although this drive has its own type of CD-RW discs, it also can burn to CD-R discs, which are much cheaper.

Some music CD players can't handle CD-R discs.

CD-RW technology enables you not only to burn a disc, but to *burn over* existing data on a CD-RW disc. This is not something you need for every disc. For example, I create CD-R archives of my completed books to store the text and graphics for posterity—this is data I want to access later but do not need to modify. While I'm still working on this book, however, I might make a backup copy. As I work on it, I'll update the backup. I couldn't do that with a CD-R. The CD-RW format, on the other hand, essentially takes CD-media to the functional equivalent of a 650-MB floppy disk. Once again, CD-RW discs look exactly like CD-ROM discs with the exception of a colored bottom side. Figure 13.21 shows all three formats.

• **Figure 13.21**   CD-ROM, CD-R, and CD-RW discs

A CD-RW drive works by using a laser to heat an amorphous (noncrystalline) substance that, when cooled, slowly becomes crystalline. The crystalline areas are reflective, whereas the amorphous areas are not. Because both CD-R and CD-RW drives require a powerful laser, making a drive that could burn CD-Rs and CD-RWs was a simple process, and plain CD-R drives disappeared almost overnight. Why buy a CD-R drive when a comparably priced CD-RW drive could burn both CD-R and CD-RW discs?

CD-RW drive specs have three multiplier values. The first shows the CD-R write speed, the second shows the CD-RW rewrite speed, and the third shows the read speed. Write, rewrite, and read speeds vary tremendously among the various brands of CD-RW drives; here are just a few representative samples: 8×4×32×, 12×10×32×, and 48×24×48×.

One of the goals with the introduction of CD-RWs was the idea of making a CD-RW act like a hard drive so you could simply drag a file onto the CD-RW (or CD-R) and just as easily drag it off again. This goal was difficult for two reasons: first, the different file formats made on-the-fly conversion risky; second, CD-RWs don't store data exactly the same way as hard drives and would quickly wear out if data were copied in the same manner.

Two developments, UDF and packet writing, enable you to treat a CD-RW just like a hard drive—with a few gotchas. The not-so-new kid in town with CD-media file formats is the **universal data format (UDF)**. UDF is a replacement for ISO-9660 and all of its various extensions, resulting in a single file format that any drive and operating system can read. UDF has taken over the DVD world (all movie DVDs use this format) and is poised to also become the CD-media file format in the near future. UDF handles very large files and is excellent for all rewritable CD-media. UDF has been available for quite a while, but until Windows Vista came out, no version of Windows could write to UDF-formatted discs. They could *read* the discs, but if you wanted to *write* to them in Windows you had to use one of a number of third-party UDF tools such as Roxio's DirectCD and Nero's InCD. UDF also supports a feature called Mount Rainier—better known as packet writing—that works with UDF so you can copy individual files back and forth like a hard drive. With UDF and packet writing, rewritable CD-media is as easy to use as a hard drive.

You can rewrite CD-RW discs a limited number of times. The number varies according to the source, but expect a maximum life of about 1000 rewrites, although in real life you'll get considerably fewer.
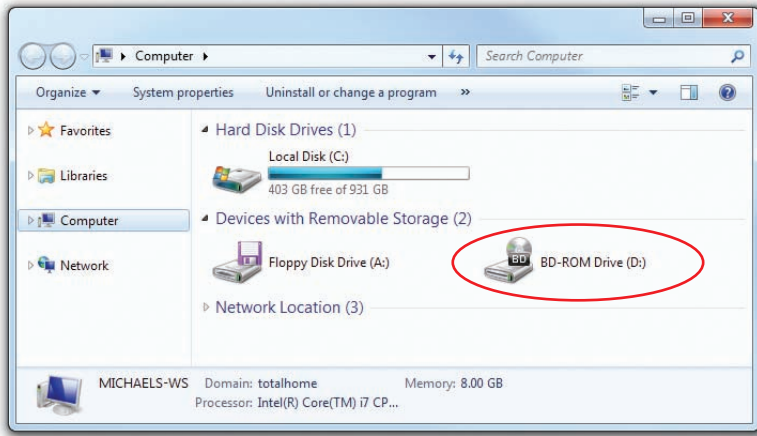
I cover more on installation and ATAPI compliance later in this chapter.

Windows and CD-Media

Virtually all optical drives are **ATAPI-compliant**, meaning they plug into the ATA controllers on the motherboard, just like a hard drive, so you don't need to install drivers. You just plug in the drive and, assuming you didn't make any physical installation mistakes, the drive appears in Windows (see Figure 13.22).

Windows displays an optical drive in My Computer or Computer with the typical optical drive icon and assigns it a drive letter. Every modern edition of Windows enables you to burn music or files to a CD using Windows Media Player or Windows Explorer, respectively. Almost every new CD-RW drive comes with some type of burner software, as well, and other third-party developers also create software that burns music and data to CD—you might have heard of Apple's iTunes software? Figure 13.23 shows the opening menu of one that I like, the popular Nero optical disc–burning program.

When I buy a new program on CD, the first thing I do is make a backup copy; then I stash the original under lock and key. If I break, melt, or otherwise destroy the backup, I quickly create a new one from the original. I can easily copy the disc, because my system, like many, has both a regular CD-ROM and a CD-RW drive (even though CD-RW drives read CD-ROM discs). I can place a CD in the CD-ROM drive and a CD-R or CD-RW disc in the CD-RW drive. Then I use a disk-copy application to create an exact replica of the CD quickly. CD-RW drives work great for another, bigger type of backup: not the archival "put it on the disc and stash it in the closet" type of backup but rather the daily/weekly backups that most of us do (or should do!) on our systems. Using CD-R discs for these backups is wasteful; once
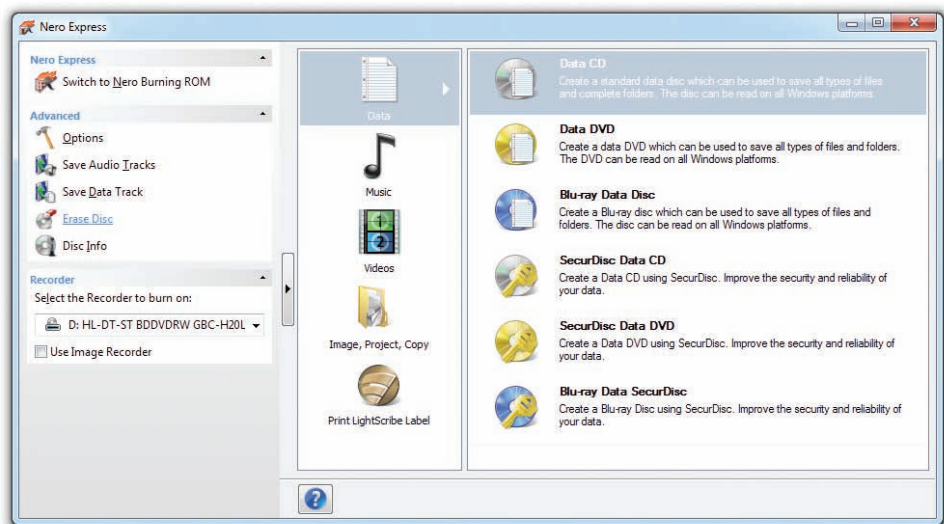
• Figure 13.23   Nero optical disc–burning program

a disc fills up, you throw it away at the next backup. But with CD-RW, you can use the same set of CD-RW discs time and again to perform backups.

Music CDs

Computers do not hold a monopoly on CD burning. Many companies offer consumer CD burners that work with your stereo system. These come in a wide variety of formats, but they're usually dual-deck player/recorder combinations. These recorders do not use regular CD-R or CD-RW discs. Instead, under U.S. law, these home recorders must use a slightly different disc called a **music CD-R**. Makers of music CDs pay a small royalty for each CD (and add it to your price). You can record *to* a music CD-R or CD-RW, but you cannot record *from* one—the idea being to restrict duplication. If you decide to buy one of these burners, make sure to buy the special music CD-Rs. Music CD-Rs are designed specifically for these types of devices and may not work well in a PC.

DVD-Media

For years, the video industry tried to create an optical-media replacement for videotape. The 12-inch-diameter *laserdisc* format originally introduced by Philips gained some ground in the 1980s and 1990s. But the high cost of both the discs and the players, plus various marketing factors, meant there was never a very large laserdisc market. You may still find one of them sitting around, however, or you may know someone who invested in a small collection during the laserdisc's heyday.

The DVD was developed by a large consortium of electronics and entertainment firms during the early 1990s and released as digital *video* discs in 1995. The transformation of DVD to a data storage medium required a name change to digital *versatile* discs. You'll still hear both terms used. The industry also uses the term **DVD-video** to distinguish the movie format from the data formats.

With the exception of the DVD logo stamped on all commercial DVDs (see Figure 13.24), DVDs look exactly like CD-media discs; but that's pretty much where the similarities end. DVD has become the fastest growing media format in history and has completely overtaken VHS as the preferred media for video. Additionally, one variant of DVD called DVD-RAM has enjoyed some success as a mass storage medium.

The single best word to describe DVD is *capacity*. All previous optical discs stored a maximum of 700 MB of data or 80 minutes of video. The lowest capacity DVD holds 4.37 GB of data, or two hours of standard-definition video. The highest capacity version DVDs store roughly 16 GB of data, or more than eight hours of video! DVD achieves these amazing capacities by using a number of technologies, but three are most important. First, DVD uses smaller pits than CD-media, and packs them much more densely. Second, DVD comes in both *single-sided* (*SS*) and *double-sided* (*DS*) formats. As the name implies, a DS disc holds twice the data of an SS disc, but it also requires you to flip the disc to read the other side. Third, DVDs come in *single-layer* (*SL*) and *dual-layer* (*DL*) formats. DL formats use two pitted layers on each side, each with a slightly different reflectivity index. Table 13.1 shows the common DVD capacities.

• Figure 13.24   Typical DVD-video

The CompTIA A+ exams refer to dual-layer DVDs as **DL DVD**, while a rewritable DVD is called a **Dual Layer DVD-RW**.

Table 13.1	DVD Versions/Capacities
DVD Version	**Capacity**
DVD-5 (12 cm, SS/SL)	4.37 GB, more than two hours of video
DVD-9 (12 cm, SS/DL)	7.95 GB, about four hours of video
DVD-10 (12 cm, DS/SL)	8.74 GB, about four and a half hours of video
DVD-18 (12 cm, DS/DL)	15.90 GB, more than eight hours of video

Tech Tip

MPEG Standards

Reproducing video and sound on the PC provides interesting challenges for developers. How do you take a motion picture from film, translate it into ones and zeros that the CPU understands, process those bits, and then send high-quality video and sound to the monitor and speakers for the pleasure of the computer user? How much data do you think is required to display even a two-minute clip of a car racing through a city street, in all the minute detail of the shops, people, screeching tires, road debris, and so on? For that matter, how do you store the obviously huge amount of data required to do this?

To handle these chores, the Moving Picture Experts Group (MPEG) has released coding standards such as MPEG-1, MPEG-2, and MPEG-4. Each standard provides a different compression algorithm, which makes the files manageable. The standards also implement various technologies to handle movement, called motion compensation. The details of the standards matter a lot to the folks producing the movies and other video and audio content, but here's the short answer that should suffice for the purposes of a PC tech.

MPEG-1 is the standard on which video and MP3, among other technologies, are based. The most common implementations of this standard provide a resolution of 352 × 240 at 30 fps. This video quality falls just below that of a conventional VHS video.

One very well-known subset of MPEG-1 is better known for audio than video. MPEG-1 Layer 3, better known as MP3 format, dominates the world of audio. MP3 takes an uncompressed audio file and compresses it dramatically, but the algorithm is so tight that the music that comes out of the speakers remains almost completely faithful to the original audio file. To paraphrase a catchphrase from the 1980s—I want my MP3s!

MPEG-2 provides resolutions of 720 × 480 and 1280 × 720 at 60 fps (as well as others), plus CD-quality audio, making it adequate for all major TV standards, even HDTV. MPEG-2 is the standard that covers DVD-ROM technology—it can compress two hours of video into a file no larger than a few gigabytes. Although encoding video into MPEG-2 format requires a computer with some serious firepower, even a modest PC can decompress and play such a video.

*The **MPEG-4** standard is based on MPEG-1, MPEG-2, and Apple's QuickTime technology. MPEG-4 graphics and video files use what's known as wavelet compression to create files that are more compact than either JPEG or QuickTime files. This superior compression makes MPEG-4 popular for delivering video and images over the Web. MPEG-4 higher-efficiency standards such as advanced video coding are included with MPEG-4 and used for Blu-ray Discs. And notably, MPEG-4 provides Intellectual Property Management and Protection (IPMP), which supports digital rights management.*

MPEG-7 is designed to complement the previous standards as a fast and efficient multimedia content searching tool.

MPEG-21 is concerned with and focuses on coding and digital rights. MPEG-21 uses a Rights Expression Language (REL) and a Rights Data Dictionary to protect digital material from illicit file sharing.

DVD-Video

The most beautiful trait of DVD-video is its capability to store two hours of video on one side. You drop in a DVD-video and get to watch an entire movie without flipping it over. DVD-video supports TV-style 4:3 aspect-ratio screens as well as 16:9 theater screens, but it is up to the producer to decide which to use. Many DVD-video producers used to distribute DVD movies on DS media with a 4:3 ratio on one side and 16:9 ratio on the other, though that isn't as common anymore. DVD-video relies on the **MPEG-2** standard of video and audio compression to reach the magic of two hours of video per side. *Moving Picture Experts Group (MPEG)* is a group of compression standards for both audio and video. The MPEG-2 standard offers resolutions of up to 1280 × 720 at 60 frames per second (fps), with full CD-quality audio (standard DVDs only offer 480 vertical resolution, the same as regular television).

DVD-ROM

DVD-ROM is the DVD equivalent of the standard CD-ROM data format except that it's capable of storing up to almost 16 GB of data. Almost all DVD-ROM drives also fully support DVD-video, as well as most CD-ROM formats. Most DVD drives sold with PCs are DVD-ROM drives.

Recordable DVD

The IT industry has no fewer than *six* distinct standards of recordable DVD-media: DVD-ROM for general use, DVD-R for authoring, **DVD-RW**, DVD+R, **DVD+RW**, and DVD-RAM. Both DVD-R standard discs and DVD+R discs work like CD-Rs. You can write to them but not erase or alter what's written. DVD-RW, DVD+RW, and DVD-RAM discs can be written and rewritten, just like CD-RW discs. Most DVD drives can read all formats with the exception of DVD-RAM. DVD-RAM is the only DVD format that uses a cartridge, so it requires a special drive (see Figure 13.25). DVD-RAM is still around but fading away.

Although there is little if any difference in quality among the standards, the competition between corporations pushing their preferred standards has raged for years. Sony and Phillips, for example, pushed the + series, whereas other manufacturers pushed the – series. Worse, no recordable DVD drive manufactured before 2003 could write any format except its own. You could plop down US$250 on a brand-new DVD+RW drive and still find yourself unable to edit a disc from your friend who used the DVD-RW format! Half of the time, the drive couldn't even *read* the competing format disc.

The situation is much better today, as DVD±RW combo drives in PCs play just about anyone else's DVDs. The challenge is DVD players. If you want to make a DVD of your family picnic and then play it on the DVD player hooked to your television, take the time to read the documentation for your player to make sure it reads that particular DVD format—not all players read all formats.

• **Figure 13.25** DVD-RAM disc

Blu-ray Disc-Media

Blu-ray Disc is considered the next generation in optical disc formatting and storage technology after CD and DVD. Because of its near-perfect audio and video quality; mass acceptance by industry-leading computer, electronics, game, music, retail, and motion picture companies; and huge storage capacities of up to 25 GB (single-layer disc) and 50 GB (dual-layer disc), Blu-ray Disc technology is expected to eventually make CD- and DVD-media and devices obsolete.

Blu-ray Discs come in two physical sizes, standard and mini. The standard size matches that of earlier optical discs, such as CD-R and DVD-RW, and is what you'll see used in computers and for movies (see Figure 13.26). The mini-size discs are a lot smaller and, naturally, offer less storage. You'll find mini Blu-ray Discs in very high-end camcorders. Table 13.2 shows the details of the two formats.

Table 11.2	Standard and Mini Blu-ray Disc Comparison Chart		
Type	**Size**	**Capacity (single layer)**	**Capacity (dual layer)**
Standard disc	12 cm	25 GB	50 GB
Mini disc	8 cm	7.8 GB	15.6 GB

There was a brief battle for supremacy in the high-definition digital war between Blu-ray Disc and a competing high-definition optical disc standard called HD DVD. Major content manufacturers and developers leaned toward Blu-ray Disc, and in early 2008, Toshiba—the primary company behind HD DVD—threw in the towel. HD DVD is no longer being developed or supported.

If you own a PlayStation 3, you already have a Blu-ray Disc player. That's the optical format the game system uses.

• Figure 13.26   Standard Blu-ray Disc

• Figure 13.27   A combination CD/DVD/Blu-ray Disc drive

Blu-ray Disc technology offers several advantages over DVD aside from raw capacity. First, Blu-ray Disc uses a blue-violet laser (hence the Blu in the name) with a wavelength of 405 nanometers (nm). (DVD uses a red-laser technology with a wavelength of 650 nm.) The 405-nm wavelength is smaller and much more precise, enabling better use of space during the creation process and ultimately resulting in a sharper image. Second, Blu-ray Disc can handle high-definition (HD) video in resolutions far higher than DVD. Finally, Blu-ray Disc supports many more video compression schemes, giving producers more options for putting content on discs.

BD-ROM

BD-ROM (read only) is the Blu-ray Disc equivalent of the standard DVD-ROM data format except, as noted earlier, it can store much more data and produces superior audio and video results. Almost all BD-ROM drives are fully backward compatible and support DVD-video as well as most CD-ROM formats. If you want to display the best possible movie picture quality on your HDTV, you should get a Blu-ray Disc player and use Blu-ray Discs in place of DVDs. Most new computer systems still don't come standard with Blu-ray Disc drives installed. You can often custom-order a system with a Blu-ray Disc drive or you can simply install one yourself. Figure 13.27 shows a Blu-ray Disc drive.

BD-R and BD-RE

Blu-ray Discs come in two writable formats, BD-R (for recordable) and BD-RE (for rewritable). You can write to a **BD-R** disc one time. You can write to and erase a **BD-RE** disc several times. There are also BD-R and BD-RE versions of mini Blu-ray Discs.

Blu-ray Disc Burners

Blu-ray Disc burners cost more than a standard optical drive but will eventually be as common as the average CD-RW or DVD-RW. Blu-ray Disc burners and other Blu-ray Disc drives can be connected internally or externally to a system. It is common for them to be connected externally via USB (3.0 usually) or eSATA or internally through SATA. Operating systems such as Windows, XP, Windows Vista, and Windows 7 all support Blu-ray Disc burners and software. The software you use for burning is totally up to you; however, as always, you should follow the manufacturer's specifications for the best results. Most multidrive Blu-ray Disc burners offer the following support features.

- **Media support** BD-R, BD-RE, DVD-ROM, DVD-RAM, DVD-video, DVD+/-R DL, DVD+/-R, DVD+/-RW, CD-DA, CD-ROM, CD-R, and CD-RW
- **Write speed (max)** 2× BD-R, 4× DVD+/-R DL, 8× DVD+/-R(8×), and 24× CD-R

- **Rewrite speed (max)**   2× BD-RE, 8× DVD+RW, 6× DVD-RW, 5× DVD-RAM, and 16× CD-RW

- **Read speed (max)**   2× BD-ROM, 8× DVD-ROM, and 32× CD-ROM

- **Compatibility**   Most Blu-ray Disc drives are backward compatible, meaning they can read and play CDs and DVDs. CD and DVD drives and players cannot read or play Blu-ray Discs.

Installing Optical Drives

From ten feet away, optical drives of all flavors look absolutely identical. Figure 13.28 shows a CD-RW drive, a DVD drive, and a BD-R drive. Can you tell them apart just by a glance? In case you were wondering, the CD-RW drive is on the bottom, the DVD drive is next, and finally the BD-R drive is on the top. If you look closely at an optical drive, you will normally see its function either stamped on the front of the case or printed on a label somewhere less obvious (see Figure 13.29).

Connections

Most internal optical drives use SATA connections (though you'll find some drives still use a PATA cable) and support the ATAPI standard. (Other connections, such as SCSI and USB, are possible but less common.) External optical drives often use USB, FireWire, or eSATA connections. ATAPI treats an optical drive exactly as though it were an ATA drive. PATA optical drives have regular 40-pin IDE connectors and master/slave jumpers. SATA optical drives use standard SATA or eSATA cables. You install them as you would install any ATA hard drive. Figure 13.30 shows a typical DVD installation using SATA.

• **Figure 13.28**   CD-RW, DVD, and BD-R drives

• **Figure 13.29**   Label on optical drive indicating its type

● **Figure 13.30**   Typical DVD installation

ATAPI drives require no CMOS changes as part of the installation process. When the industry first introduced ATAPI drives, techs familiar with hard-drive installations swamped the CD-ROM makers' service departments asking how to set up the drives in CMOS. To reduce these calls, BIOS makers added a CD-ROM option in many CMOS setup utilities, just to give the techs something to do! You can find this option in many older CMOS setup utilities. This setting actually didn't do anything at all; it just kept users from bothering the CD-ROM makers with silly support calls. Modern motherboards report the actual model numbers of optical drives,

---

☑ Cross Check

Master/Slave Settings

You normally set up a PATA optical drive as a slave to a hard drive master. You learned about master and slave settings for PATA drives in Chapter 11, so cross-check your memory!

1. What are the various ways you can determine which drive on an IDE controller acts as slave and which acts as master?

2. What factors should you consider when deciding where to install an optical drive, either as a master or as a slave? Is there any difference in your answer for a system with one hard drive versus one with two hard drives?

giving techs a degree of assurance that they configured and installed the drive correctly (see Figure 13.31).

Device Manager

When you install a new optical drive, such as a DVD drive, into an existing system, the first question to ask is "Does Windows recognize my DVD drive?" You can determine this by opening My Computer/Computer and verifying that a DVD drive is present (see Figure 13.32). When you want to know more, go to Device Manager.

• **Figure 13.31**   Autodetect settings for two optical drives

Device Manager contains most of the information about optical drives. Open Device Manager and find your drive in the list of devices. Right-click on the drive and select Properties to see more information. The General tab tells you about the current status of the DVD drive, basically saying whether the device is working properly or not—rather less useful than actually trying the device. Other tabs, such as the Driver tab, provide other pertinent information about the drive.

Auto Insert Notification

Another setting of note is the Auto Insert Notification option, often referred to as **AutoPlay**. This setting enables Windows to detect automatically the presence of audio or data optical discs when they are placed in the drive. Windows XP and Windows Vista/7 deal with AutoPlay in different ways.

Windows XP provides a simple approach to AutoPlay. By default, when you insert a CD- or DVD-media disc that doesn't have an **autorun.inf** file, Windows XP asks you what you want to do (see Figure 13.33). You can change the default behavior simply by accessing the Properties dialog box

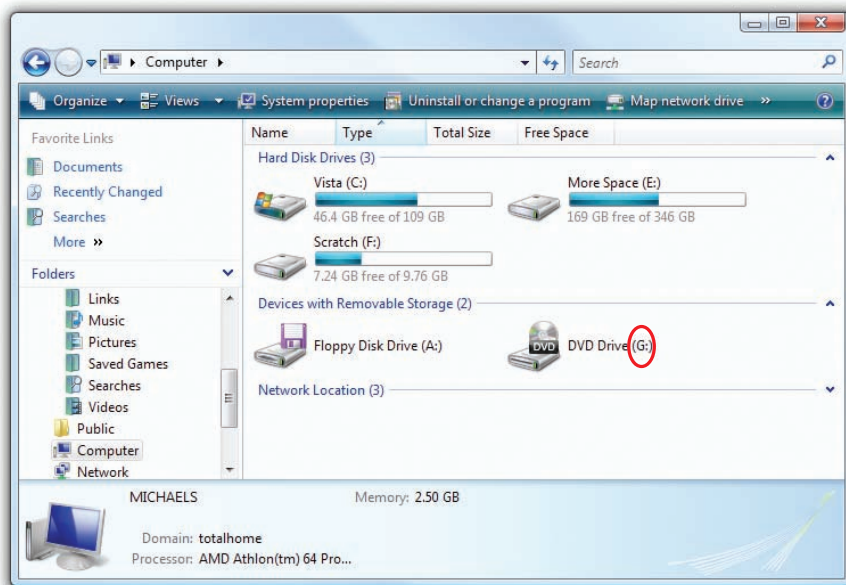• **Figure 13.32**   DVD drive letter in Computer

---

Tech Tip

External Optical Drives

Almost all new PCs have one, two, or three external expansion buses—USB, FireWire, or eSATA—and the makers of optical drives have quickly taken this fact to heart. Many manufacturers have released external versions of CD, DVD, and Blu-ray Disc drives, both readers and burners. Of the three, eSATA is fastest, with USB 3.0 close behind and FireWire a distant third.

Many ultra-light laptops don't have an optical drive built in; the only way to load an OS on them is through an external drive.

You won't find many CD or DVD drives with eSATA—they just can't take advantage of the blazing speed offered by the best of the external ports. Blu-ray Disc drive manufacturers, on the other hand, have released several drives with both eSATA and USB 3.0 connections. Since both connections offer almost the same speed (in practical usage, at least), feel free to use either connection.

• **Figure 13.33**   Windows XP prompting user for action
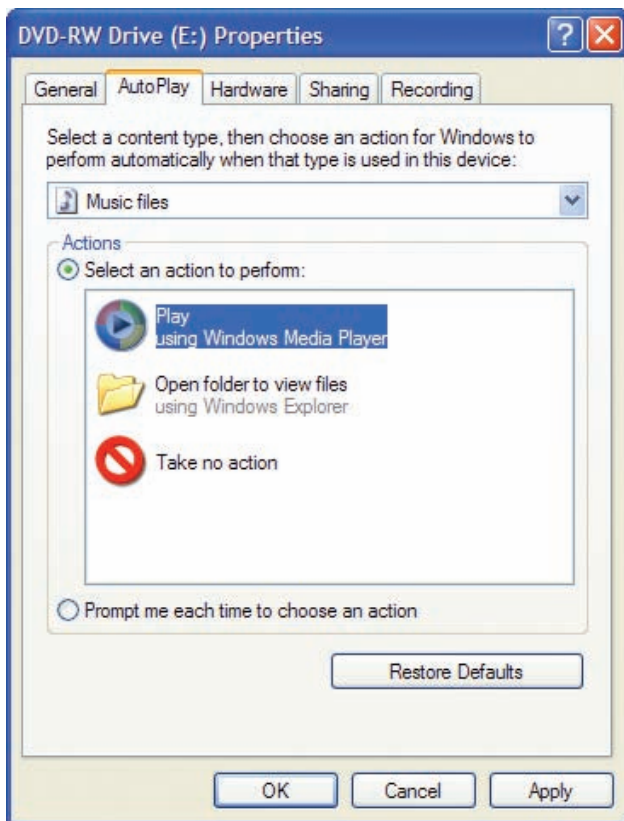
• **Figure 13.34**   AutoPlay tab for a CD-RW drive

for a particular drive in My Computer and making your selection on the AutoPlay tab. Figure 13.34 shows some of the options for a typical Windows XP machine.

AutoPlay in Windows Vista and Windows 7 is much more robust and offers many more options than in Windows XP. For example, you can choose to enable or disable AutoPlay for all media and devices. (Using AutoPlay for all media and devices is the default.) But what's more interesting is that you can enable very specific actions for Windows to take when digital media or devices are inserted or detected. For an audio CD, for example, you can specify that Windows should use Windows Media Player. If a DVD or Blu-ray movie is detected, you can tell AutoPlay to play the disc by using PowerDVD 12 or some other program. You can adjust AutoPlay options in Windows Vista/7 through Control Panel | Hardware and Sound | AutoPlay.

You can also change the drive letter for an optical drive, just as you can change the letter of a hard drive. You'll find that option in Disk Management (see Figure 13.35).

Applications

A regular CD-ROM drive installation involves no applications. You install it, Windows sees it, and you're finished. CD-R and CD-RW drives, in contrast, require applications to enable their burning features. Windows Media Player, included with most copies of Windows, is capable of burning music to CDs, while Windows Explorer can burn data to your CDs.

DVD and Blu-ray Disc drives need software to enable you to watch movies and burn DVD and Blu-ray video, though burning your data to DVD is still handled by Windows Explorer. (Burning to Blu-ray media requires third-party software.) Windows Media Player makes an excellent DVD-watching application, but to burn DVD-videos, you'll need to turn to Windows DVD Maker (Vista/7) or a third-party tool like Nero or Roxio Creator.

Ever wanted to make a perfect copy of a CD so you can keep your original in a safe place? You can do so by using a special file type called an ISO file. An **ISO file** is a complete copy—an ISO image as we say—of an optical disc. As you might imagine, they are huge files, but they are also very important to techs. Techs use ISO images to send each other copies of bootable utility discs. For example, if you want a copy of the Ultimate Boot CD, you go to their Web site and download an ISO image. With Windows XP and Windows Vista, you'll need a third-party burning program (Windows 7 can burn ISO images) and go through a special process called burning an ISO image. Learn how to burn ISO images with your burning program; you'll use it all the time.
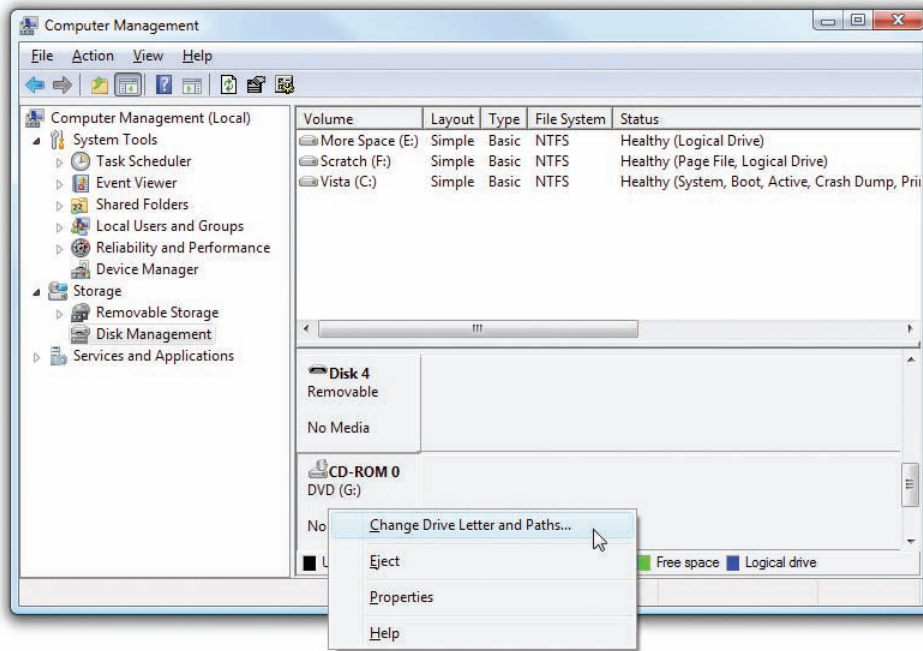
● **Figure 13.35** Change CD drive letter option in Disk Management

Blu-ray Disc Drive Considerations

Physically installing, attaching, and maintaining optical drives is pretty straightforward, but a Blu-ray Disc drive installation requires some special considerations. If you plan to use your Blu-ray Disc drive primarily for storage purposes, for example, system requirements are minimal. If you plan on watching Blu-ray Disc movies in HD resolution (720p, 1080i, or 1080p), on the other hand, the requirements are quite hefty. Here's a list of recommended minimum specs.

- ■ **Processor**   At the very least, a Pentium 4, Pentium D, or dual or multicore processor; or an AMD Athlon 64 X2 or Phenom multicore processor.

- ■ **System memory**   At least 1 GB RAM for Windows XP; 2 GB RAM for Windows Vista/7.

- ■ **Video**   You need an HDCP-compliant (either DVI or HDMI) video card and drivers. That's a lot of initials in one sentence! Here's the scoop. The High-Bandwidth Digital Content Protection (HDCP) is a standard developed by Intel to ensure copyright protection on behalf of the Motion Picture Association of America. The digital visual interface (DVI) and High-Definition Multimedia Interface (HDMI) standards enable fast, uncompressed connections between an HDTV, PC, and any other DVI/HDMI component. HDMI, which transmits both video and audio signals, has all but replaced the older DVI standard that only supports video. AMD and NVIDIA both offer Blu-ray Disc–compliant PCIe video cards with enough horsepower to get the job done.

Burning Digital Music Files to a CD

Almost all computers and many portable CD players now can play recordable CDs loaded with MP3 files. This enables you to mix songs from your music collection and fit a lot of songs on a disc (MP3s are smaller than CD-audio files). That's a great feature—but where do digital audio files come from and how do you put them on a CD?

You can create MP3s from your favorite CDs by using a *ripper*. A ripper is a piece of software that takes standard CD-audio files and compresses them, using specialized algorithms, into much smaller files while maintaining most of the audio qualities of the original file. One legal note, however: you should only make MP3s from CDs that you have purchased. Borrowing a CD from a friend and ripping MP3s from it is illegal! Likewise, downloading MP3s from unauthorized sources on the Internet is also illegal. You don't want to go to jail because you just had to listen to the latest, greatest single from your favorite artist, right?

Now that I've taken care of the legal disclaimer, get ready to burn your MP3s. You need three things: a recordable/rewritable optical drive, some CD authoring software, and, of course, a blank disc. I recommend a CD-R. (Audio-only devices stand a much better chance of playing a CD-R successfully rather than a CD-RW.)

1. Confirm that you have a CD-R/RW drive installed in your computer. You don't have to have a drive like this to rip audio files *from* a CD, but you must have one to burn digital audio to a CD-R.

2. Launch your favorite CD authoring software. Popular titles in this category include Nero Burning ROM and Roxio Creator.

3. Most CD authoring programs use a simple drag-and-drop interface, similar to the Windows Explorer interface. Browse to the location of the audio files and select them. Then drag them into the appropriate area—this is often called the *queue*.

4. After you've selected all the files you want to have on your CD, it's time to burn. The procedure for initiating the CD-burning sequence is different for each program. You should always make sure to *close* the CD after you've burned it. Most standalone CD players (even ones that play MP3s) won't play CD-Rs that haven't been closed.

Once you've keyed in all of the configuration information, just sit back and watch the fireworks. Always be sure to use CD-media that is rated appropriately for your drive, for both speed and media type. In no time at all, you'll be listening to MP3s while jogging around the park.

CyberLink provides an awesome tool called BD & 3D Advisor that will tell you if your system meets the requirements to play Blu-ray Discs. You can get it at www.cyberlink.com/prog/bd-support/diagnosis.do.

Region Codes

Production movies on DVD and Blu-ray Disc can feature a **region code**, encoding that enables you to play those movies only on a player that shares the same region code. This was instituted to try to stop piracy of movies, though it didn't manage to accomplish that goal.

Can you play a DVD or Blu-ray Disc encoded to play in the geographical region location of Somalia on your system manufactured in the U.S.A.? Why sure you can. To do so, however, you have to change the region code on your DVD or Blu-ray Disc player to match Somalia (5 or B, respectively, in case you're curious). You can only change the region code on your player four times. After that, you get stuck with whatever was the last-used region code.

Most optical devices are set to play only discs encoded for the region in which they were sold or manufactured. You can easily check and set your device's current region code under the hardware properties of your optical device in any version of Windows. As either a technician or home enthusiast, you should be familiar with the following optical device and media region codes.

> Be sure you are familiar with the Blu-ray Disc requirements discussed in this section, especially the stringent requirements for supporting high-definition video and audio. Also, be aware that CompTIA expects you to be somewhat knowledgeable of DVD/BD region codes, so pay attention to those as well.

DVD Region Codes:

- **REGION 0**   All regions
- **REGION 1**   United States, Canada
- **REGION 2**   Europe, Japan, Middle East, South Africa, Greenland
- **REGION 3**   South Korea, Taiwan, Hong Kong, areas of Southeast Asia
- **REGION 4**   Australia, New Zealand, Central and South America
- **REGION 5**   Eastern Europe, Russia, India, Africa
- **REGION 6**   China
- **REGION 7**   Reserved for special and future use
- **REGION 8**   Reserved for cruise ships and airlines

Blu-ray Disc Region Codes:

- **A**   East Asia (China and Mongolia excluded), Southeast Asia, Americas, and their dependencies
- **B**   Africa, Southwest Asia, Europe (except Russia), Oceania, and their dependencies
- **C**   Central Asia, East Asia (China and Mongolia only), South Asia, central Eurasia (including Russia), and their dependencies

■ Troubleshooting Removable Media

Floppy disk drives, flash memory, and optical drives are fairly robust devices that rarely require troubleshooting due to an actual hardware failure. Most problems with removable media stem from lack of knowledge, improper installation, abuse, and incorrect use of associated applications.

There's no way to repair a truly broken flash memory card—once a flash card dies you replace it—so let's concentrate on troubleshooting floppy drives and optical drives.

Floppy Drive Maintenance and Troubleshooting

No single component fails more often than the floppy drive. This is not really that surprising because floppy drives have more exposure to the outside environment than anything but the keyboard. Only a small door (or in the case of 5¼-inch drives, not even a door) divides the read/write heads from dust and grime. Floppy drives are also exposed to the threat of mechanical damage. Many folks destroy floppy drives by accidentally inserting inverted disks, paper clips, and other foreign objects. Life is tough for floppy drives.

In the face of this abuse, the key preventative maintenance performed on floppy drives is cleaning. You can find floppy drive **cleaning kits** at some electronics stores, or you can use a cotton swab and some denatured alcohol to scour gently inside the drive for dust and other particles.

If cleaning the drive doesn't help, try replacing the suspect disk with another one to see if the floppy drive itself is bad. If it turns out that your floppy drive won't read any disks, it's time to replace the drive.

Troubleshooting Optical Drives and Discs

Optical drives are extremely reliable and durable PC components. At times, however, a reliable and durable device decides to turn into an unreliable, nondurable pile of plastic and metal frustration. This section covers a few of the more common problems with optical drives and discs—installation issues, burning issues, and firmware updates—and how to fix them.

Installation Issues

The single biggest problem with optical drives, especially in a new installation, is the connection. Your first guess should be that the drive has not been properly installed in some way. A few of the common culprits are forgetting to plug in a power connector, inserting a cable backward, and misconfiguring jumpers/switches. Although you need to know the type of drive, the test for an improper physical connection is always the same: using BIOS to see whether the system can see the optical drive.

How BIOS detects an optical drive depends on the system. Most BIOS makers have created intelligent BIOS software that can see an installed CD-media drive. Figure 13.36 shows a modern Award Software, Inc. BIOS recognizing a CD-RW during startup.

If BIOS detects the device, Windows recognizes the drive and you'll see it in My Computer/Computer and Device Manager.

If the drive won't read a CD-R or CD-RW disc, first try a commercial CD-ROM disc that is in good condition. CD-R and CD-RW discs sometimes have compatibility issues with CD-ROM drives. The same goes for DVD-RWs or any other writable DVD discs in your DVD drive or writable

```
●Award Modular BIOS v6.00PG, An Energy Star Ally
▞Copyright (C) 1984-2003 Phonix Technologies, LTD


Main Processor : AMD Athlon(tm) 64 Processor 3200+
Memory Testing : 1048576K OK
CPU0 Memory Information: DDR 400 CL:3 ,1T Dual Channel, 128-bit

IDE Channel 1 Master : WDC WD1200JB-75CRA0 16.06V16
IDE Channel 1 Slave  : None
IDE Channel 2 Master : TOSHIBA CD=DVDW SDR5372V TU11
IDE Channel 2 Slave  : None
```

• **Figure 13.36**   BIOS recognizing an optical drive at boot

Blu-ray Discs in your Blu-ray Disc drive. Also, no optical drive will read badly scratched discs.

If the drive still does not see a disc, try cleaning the drive. Most modern optical drives have built-in cleaning mechanisms, but from time to time, you need to use a commercial optical-drive cleaning kit (see Figure 13.37).

Optical drives are not cleaned too often, but the discs are. Although a number of fine optical disc cleaning kits are available, you can clean most discs quite well with nothing more than a damp soft cloth. Occasionally, you can add a mild detergent. Always wipe from the center of the optical disc to the edge—never use a circular motion when cleaning a CD, DVD, or Blu-ray Disc! A common old tech's tale about cleaning optical discs is that you can wash them in a dishwasher. Although this may seem laughable, the tale has become so common that it requires a serious response. This is *not true* for two reasons: First, the water in most dishwashers is too hot and can cause the discs to warp. Second, the water pushes the discs around, causing them to hit other objects and get scratched. Don't do it!

The final problem with optical drives—stuck discs—comes from *technician* error and is not actually the fault of the drives. I can't tell you the number of times I've pulled an optical drive out of a system to replace it, only to discover that I or my customer left an essential disc inside the now-powerless drive. Luckily, most optical drives have a small hole in the front, usually just below the drive opening, into which you can insert a wire—an unbent paper clip is the standard tool for this purpose—and push on an internal release lever that ejects the disc. Try it!

Burning Issues

The tremendous growth of the CD-R and CD-RW industry—and to a lesser extent, the recordable DVD industry—has led to a substantial number of incompatibility issues between discs and drives. Some of these incompatibilities trace back to serious IO (Ignorant Operator) problems; people try to make these discs do jobs they aren't designed to do. Even when people read the manuals and jump through the proper hoops, real problems do arise, many of which you can easily solve with a few checks.
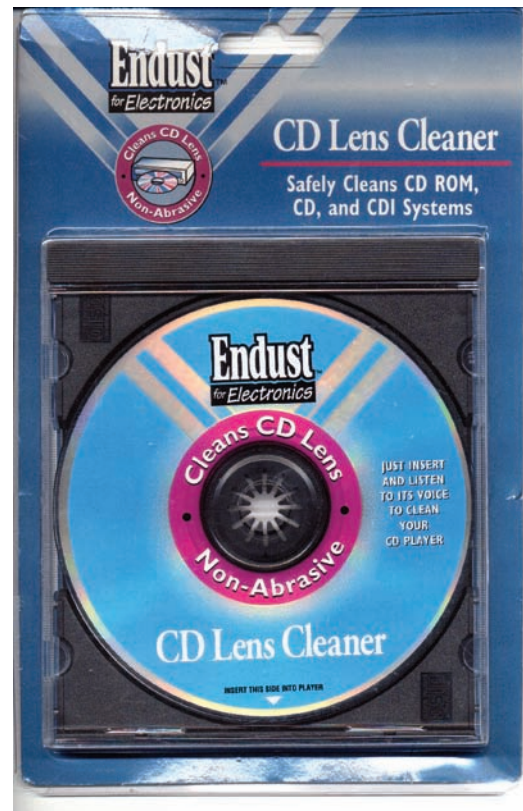
• **Figure 13.37**   Optical-drive cleaning kit

Know What It Can Do   Most mistakes take place at the point of purchase, when someone buys a drive without completely understanding its capabilities. Don't just assume that the device will do everything. Before I purchase a CD-RW or DVD-RW drive, for example, I make it a point to get my hands on every technical document the maker provides to verify exactly what capabilities the drive possesses. I make sure the drive has a good reputation; just use any search engine and type in **review** and the model number of the drive to get several people's opinions.

Media Issues   The optical disc standards committees refused to mandate the types of materials used in the construction of discs. As a result, you see substantial quality differences among CD-R and CD-RW discs of different brands and sources (they are made in several different countries). As mentioned earlier, CD-R discs use organic inks as part of the burning process. Fellow techs love to talk about which color to use or which color gives the best results. Ignore them; the color itself means nothing. Instead, try several brands of CD-R discs when you first get your drive to determine what works best for you. If you have a particular reason for burning CDs, such as music recording, you may want to ask for opinions and recommendations among folks in online communities with the same focus. They're usually happy to share their hard-won knowledge about what works.

In general, two items can affect media quality: speed and inks. Most CD-R and CD-RW media makers certify their CDs to work up to a certain speed multiplier. A media maker often has two product lines: a quality line guaranteed to work at a certain speed, and a generic line where you take your chances. As a rule, I buy both. I primarily use cheap discs, but I always stash five to ten good-quality discs in case I run into a problem. Again, this in large part depends on what you want them for: you may want to pull out the cheapies for temporary backups but stick with the high-end discs for archiving musical performances.

All of this discussion about CD-Rs and CD-RWs definitely holds true for recordable DVD and BD discs and drives as well. Factor in the incompatibility of standards and you're looking at a fine mess. Do your homework before you buy or advise a client to buy a DVD/BD-writable or -rewritable drive.

Buffer Underrun   Every CD, DVD, and Blu-ray Disc burner comes with onboard RAM, called *buffer RAM*—usually just called the buffer—that stores the incoming data from the recording source. **Buffer underrun**, the inability of the source device to keep the burner loaded with data, creates more *coasters*—that is, improperly burned and therefore useless CDs, DVDs, and Blu-ray Discs—than any other single problem. Buffer underrun most often occurs when copying from CD-ROM to CD-R/RW or from DVD-ROM to DVD-writable of all stripes. Many factors contribute to buffer underrun, but two stand out as the most important. The first factor is buffer size. Make sure you purchase drives with large buffers, a minimum of 2 MB. Unlike with system RAM, you can't get a buffer upgrade. Second is multitasking. Most systems won't enable you to run any other programs while the burner is running.

One trick to reduce underrun is using an ISO image file. Unlike some optical drives, *any* hard drive can keep up with an optical burner. Doing a bit-by-bit copy from disc to disc dramatically reduces the chances that a buffer underrun will add to your coaster collection. All current optical disc burners include the BURN-Proof technology developed by Sanyo, which has eliminated the underrun issue. These drives can literally turn off the burning process if the buffer runs out of information and automatically restart as soon as the buffer refills. I love this feature, as I can now burn CDs in the background and run other programs without fear of underrun. If you're buying a new burner, make sure you get one that uses the BURN-Proof technology.

Firmware Updates

Almost all optical drives come with an upgradeable flash ROM chip. If your drive doesn't read a particular type of media, or if any other nonintermittent reading/writing problems develop, check the manufacturer's Web site to see if it offers a firmware upgrade. Almost every optical drive seems to get one or two firmware updates during its production cycle.

The majority of problems that occur with CD, DVD, and Blu-ray Disc drives are usually a direct result of incorrectly installed or updated device drivers, disconnected cables, or incompatible or just plain bad media. Also, keep in mind DVD and Blu-ray Disc drives use specific region codes that are often misconfigured. Blu-ray Disc drives have very specific hardware and driver specifications that must be met for trouble-free end-user experiences. CompTIA is likely to target these areas, so make sure you understand this information.

Beyond A+

Color Books

The term *color books* is often used in the world of CD-media. Color books are—well, books! In this case, they're the standards developed in the industry to describe various media. For example, the Red book describes the original audio CD format. If you have a lot of money—say, US$3000—you may purchase copies of these books, and yes, their covers really match the colors of the standards. You might hear a fellow computer support person using these terms. Instead of saying, "Does your CD-ROM read CD-RWs?" they will say, "Is that CD-ROM of yours Orange book?" Technical specifications also use these terms. I personally don't like the way many people refer to these book colors, but the terms are used enough that you should memorize the meanings of at least three book colors: Red, Yellow, and Orange. Table 13.3 shows a complete list of CD-media book colors.

Table 13.3	CD-Media Book Colors
Application	**Book**
Audio CDs	Red book
Data CDs	Yellow book
CD-I	Green book
Recordable CDs	Orange book
Video CD	White book
CD Extra	Blue book

BDXL

If you think Blu-ray Disc's 50-GB capacity is limiting, check out *BDXL* discs. The BDXL format was introduced in June 2010, although drives capable of reading and writing to the discs didn't start appearing until late 2011. That's right: you can't use BDXL discs in that standard Blu-ray Disc drive you just bought. You'll need a drive that specifically supports the new format. So why would you want one? In a word: capacity.

BDXL discs come in two flavors: a triple-layer BDXL disc supports a capacity of 100 GB, and a quadruple-layer disc has a capacity of 128 GB. That's a lot of room, but it comes at a high price. As of early 2012, a single disc cost US$100—that's a dollar per gigabyte for a triple-layer disc! At those prices, you could go out and get yourself a nice solid-state drive, which is much more flexible as a storage device. Needless to say, BDXL isn't quite ready for the spotlight, but as prices come down, this could become a great option for optical disc storage.

Chapter 13 Review

■ Chapter Summary

After reading this chapter and completing the exercises, you should understand the following about floppy disk drives, flash memory, and optical media technology.

Explain and install floppy disk drives

■ Floppy disk drives are a thing of the past. The small, 1.44-MB capacity floppy disks have been replaced by higher-capacity removable media.

■ Floppy disks are constructed of a flexible magnetic disc housed inside a square plastic case. The case has a sliding protective cover that opens to reveal a portion of the magnetic media when inside a floppy drive. Read/write heads inside the floppy disk drive move back and forth across the media, reading or writing data as necessary.

■ During disk access, an LED on the front of the drive lights up. Never eject a floppy disk when this light is on.

■ Floppy disks appeared around 1986 and are 3½ inches.

■ You may have a maximum of two floppy disk drives in a system, and they must use either the drive letter A: or B:; however, a single floppy disk drive can be configured to use either drive letter. By convention, if your system has only one floppy disk drive, you should configure it as drive A:.

■ A 34-pin ribbon data cable is used to connect the floppy disk drive to the motherboard; a 4-pin mini connector supplies power. Attaching the data cable backward won't damage anything, but the drive won't work. If you attach the power connector incorrectly, you risk damaging the drive.

■ Most floppy ribbon cables have three connectors and a twist. The end without the twist connects to the motherboard, matching the red stripe on the cable with pin 1 of the motherboard connector. The drive attached to the middle connector on the cable receives the drive letter B:. The drive attached to the other end of the cable (after the twist) is assigned the drive letter A:.

■ After connecting a floppy disk drive, configure the CMOS settings. Make sure the CMOS settings match your floppy disk drive size/capacity; for example, 3½ inches and 1.44 MB.

Demonstrate the variations among flash drives and other tiny drives

■ Flash memory includes USB thumb drives and memory cards. USB thumb drives contain a standard USB connection and have replaced many other forms of removable media as the way to transfer files. Memory cards, a generic term, are used in digital cameras, smartphones, and other devices.

■ Thumb drives store much more data than floppies—sometimes up to the equivalent of thousands of floppy disks. They are hot-swappable in Windows and don't require an external power source, as they are powered directly from the USB. Most new PCs enable you to boot from a USB thumb drive.

■ Flash cards, which are used in portable devices such as digital cameras, smartphones, and MP3 players, come in many varieties. The most common types are CompactFlash, Secure Digital, Memory Stick, and Extreme Digital (xD) Picture Card.

■ CompactFlash cards are the oldest of the common types of flash cards. At about 1 inch wide, they use the PCMCIA bus and come in two thicknesses: CF I at 3.3 mm thick and CF II at 5 mm thick.

■ Secure Digital is perhaps the most popular flash card today. Smaller versions of Secure Digital cards, MiniSD and MicroSD, are also available.

■ Memory Stick, a proprietary format from Sony, comes in several formats, including Standard, Pro, Duo, Pro Duo, and Micro.

■ xD Picture Cards, developed by Olympus, are about half the size of Secure Digital cards and are used almost exclusively in digital cameras.

■ No matter what type of flash card you have, you need a card reader to access it. Some PCs have built-in card readers. External USB card readers are also available. Sometimes a device such as a digital camera or smartphone can double as a card reader.

Identify and install optical-media technology

- CDs store data by using microscopic pits burned into a glass master CD with a powerful laser. Expensive machines create plastic copies of the glass master that are then coated with a reflective metallic coating. CDs store data on one side of the disc only. The CD drive reads the pits and the non-pitted areas (lands) and converts the pattern into ones and zeros.

- CDs come in many varieties. CD-Digital Audio is for playing music, but it lacks error checking, file support, and directory structure. CD-ROM discs are for storing data. They use the ISO-9660 file system, also known as CDFS. Extensions of ISO-9660 have offered improvements to file and directory naming, filename length, and directory depth.

- CD-ROM speeds have increased substantially from the original 150 KBps. Increased speeds are measured in multiples of 150 KBps, so a 10× CD-ROM has a maximum speed of 1500 KBps.

- CD-recordable (CD-R) discs hold either 650 MB or 700 MB and can store either audio or data. Special organic dyes that give the CD-Rs their distinctive bottom color aid in the burning process. A strong laser in the CD drive heats the dye and changes the reflectivity of the CD-R's surface, resulting in a reflective/less-reflective pattern that is converted to ones and zeros. Once data is burned to a CD-R, the data cannot be erased. With multisession drives, you can burn data to a portion of a disc and then go back later and burn more data to the disc. CD-R discs are rated with two speeds: a write speed followed by a read speed.

- CD-rewritable (CD-RW) discs, unlike CD-Rs, enable you to erase data and burn new data. CD-RWs are rated with three speeds: write speed followed by rewrite speed followed by read speed. The UDF file format (the replacement for ISO-9660) handles large files better than CDFS. Packet writing, a feature used by UDF, allows you to copy files back and forth to a CD-RW like a hard drive.

- Most CD drives are ATAPI-compliant and do not need drivers installed for them to work.

- Windows can burn CD-Rs, CD-RWs, and all forms of burnable DVDs without additional software, but it cannot burn to Blu-ray Discs. If you need to burn to Blu-ray Disc, you need a third-party application.

- Many companies offer standalone CD burners that attach to your stereo system instead of your PC; however, these machines use a different type of CD called a music CD-R and are not compatible with standard CD-R or CD-RW discs.

- DVDs were released as digital video discs in 1995, but as usage evolved to include data storage, the name was changed to digital versatile disc. The lowest capacity DVD holds 4.37 GB of data. DVDs offer much higher capacities than CDs, because DVDs use smaller and more densely packed pits, can be burned on both sides of the disc, and can burn two layers of pits per side for a total of four layers. DVD-video uses the MPEG-2 video standard and can store two hours of video on a single side.

- DVD-ROM, the DVD equivalent of CD-ROM, can store up to 16 GB of data. Recordable DVD-media comes in many varieties: DVD-R for general purpose, DVD-R for authoring, DVD+R, DVD-RW, DVD+RW, and DVD-RAM. You can write to DVD-R and DVD+R but not erase them. You can both burn and erase DVD-RW, DVD+RW, and DVD-RAM.

- Standard Blu-ray Discs have storage capacities of up to 25 GB (single-layer disc) and 50 GB (dual-layer disc) and provide near-perfect picture quality.

- You can write to a BD-R (recordable) disc one time. You can erase and write to a BD-RE (rewritable) disc several times.

- Blu-ray Disc external devices are connected via USB, FireWire, or eSATA and internally via PATA, SATA, SCSI, or USB connections.

- Most Blu-ray Disc burners support BD-R, BD-RE, DVD-ROM, DVD-RAM, DVD-video, DVD+/-R DL, DVD+/-R, DVD+/-RW, CD-DA, CD-ROM, CD-R, and CD-RW formats. CD and DVD drives do not support Blu-ray Disc technologies. Most optical drives use SATA connections and support the ATAPI standard. PATA drives use a regular 40-pin IDE connector; SATA drives use a standard SATA or eSATA (for external use) connector. You install them just as you would any ATA hard drive. After installing a new optical drive, check My Computer/Computer or Device Manager to confirm that Windows sees the drive.

- The Windows feature Auto Insert Notification (or AutoPlay) causes Windows to automatically begin an action when an optical disc is inserted in the drive. Windows XP's AutoPlay can be configured by accessing the AutoPlay tab in the drive's Properties dialog box. AutoPlay options in Windows Vista and Windows 7 can be adjusted through Control Panel | Hardware and Sound | AutoPlay.

- An ISO file is a complete copy of an entire CD, DVD, or Blu-ray Disc. Windows XP and Windows Vista can't burn an ISO image back to disc, though Windows 7 and third-party programs such as Nero or Roxio Creator can.

Troubleshoot removable media

- The key preventative maintenance for floppy drives is cleaning. If your floppy drive won't read a disk, try another. If your floppy drive won't read any disks, replace the drive.

- If your optical drive doesn't work, first check the installation. Specifically, look at the master/slave jumper settings, data cable, and power cable. If the drive is seen by Windows but can't read a particular disc, try a commercial disc. It's also possible that your drive doesn't support your media type; for example, your DVD-R drive may not be able to read your DVD+RW disc. Clean the disc with a soft damp cloth, wiping from the center toward the edge. Never clean an optical disc in the dishwasher!

- If an optical disc becomes stuck in a drive, or if the drive has no power and you need to eject the disc, straighten a paper clip and look for the small hole on the front of the drive. Insert the paper clip in the hole and push the internal release lever to eject the disc.

- Not all media brands are created equally, and not all drives play nicely with all brands of media. Experiment and try several brands of media until you find one that works reliably with your drive.

- DVD and Blu-ray Disc drives have very specific hardware and driver specifications that must be met and use specific region codes that are often misconfigured. If a user is experiencing problems with a Blu-ray Disc device, it is likely to be associated with a video adapter, driver, or noncompliant media issue.

- A buffer underrun is caused when the source device fails to keep the recording device loaded with data. Buffer underruns are the leading cause of improperly burned, and therefore useless, CDs, DVDs, and Blu-ray Discs. Purchase a drive with a large buffer—at least 2 MB. Some drives protect against buffer underruns with a technology called BURN-Proof. Purchase a BURN-Proof drive and your buffer underruns will be eliminated.

- Most optical drives come with an upgradeable flash ROM chip. If your drive is suffering read/write problems, check the manufacturer's Web site for a firmware upgrade.

■ Key Terms

3½-inch floppy drive *(430)*
34-pin ribbon cable *(430)*
ATAPI-compliant *(442)*
AutoPlay *(449)*
autorun.inf *(449)*
BD-ROM (*446*)
Blu-ray Disc (BD) *(437)*
Blu-ray Disc recordable (BD-R) *(446)*
Blu-ray Disc rewritable (BD-RE) *(446)*
buffer underrun *(456)*
card reader *(436)*
CD-Digital Audio (CDDA) *(438)*
CD File System (CDFS) *(439)*
CD-recordable (CD-R) *(440)*

CD-rewritable (CDRW) *(440)*
CD-ROM *(438)*
cleaning kit *(454)*
compact disc (CD) *(437)*
CompactFlash (CF) *(434)*
digital versatile disc (DVD) *(437)*
DL DVD *(443)*
Dual Layer DVD-RW *(443)*
DVD-ROM *(444)*
DVD-RW *(445)*
DVD+RW *(445)*
DVD-video *(443)*
Extreme Digital (xD) Picture Card *(436)*
floppy disk *(430)*

floppy drive *(430)*
ISO file *(450)*
ISO-9660 *(439)*
Memory Stick *(435)*
microdrive *(434)*
mini power connector *(432)*
MPEG-2 *(444)*
MPEG-4 *(444)*
multisession drives *(440)*
music CD-R *(443)*

optical disc *(437)*
optical drive *(437)*
pin 1 *(431)*
region code *(453)*
removable media *(428)*
Secure Digital (SD) *(435)*
SmartMedia *(435)*
universal data format (UDF) *(441)*
USB thumb drive *(434)*

■ Key Term Quiz

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

1. If you want to burn part of a disc and finish burning it at a later time, you need to select a(n) _____.

2. Drives with BURN-Proof technology were designed to eliminate the problem of _____.

3. The first kind of CD disc was the _____ that is still used for music but is inappropriate for data because it lacks any error correction techniques.

4. While a CD-ROM disc holds about 650 MB of data, a(n) _____ stores from 4.37 GB to 15.9 GB, depending on the number of sides and layers used.

5. Floppy drives use a(n) _____ to connect the floppy drive to the motherboard.

6. The red stripe on a floppy drive cable must be oriented to _____ on the controller.

7. Currently, the most popular flash memory cards are _____.

8. The floppy disk has been replaced by the _____ because of its large capacity and portability.

9. DVD-video uses the _____ standard of video.

10. DVDs use the _____ file structure.

■ Multiple-Choice Quiz

1. You just installed a floppy drive and you notice that the floppy drive LED stays on. What is most likely the problem?

    A. You attached the floppy drive to the wrong connector on the ribbon cable.

    B. You forgot to configure the floppy drive through the CMOS setup.

    C. You did not attach the colored stripe on the ribbon cable to pin 1 at the drive or at the controller.

    D. You forgot to attach the power cable to the floppy drive.

2. If the floppy disk you used last week will not work today in your floppy drive, what should you do first to determine if the problem is the drive or the disk?

    A. Try another disk in the drive or try the disk in another drive.

    B. Open the computer and check the ribbon cable.

    C. Replace the floppy drive.

    D. Check the CMOS settings.

3. What kind of disc must you use in a non-PC CD burner that works with your stereo system?

    A. CDDA

    B. CD-RW

    C. CD-UDF

    D. Music CD-R

4. What is the minimum capacity of a DVD?

   A. 650 MB

   B. 3.47 GB

   C. 4.37 GB

   D. 7.34 GB

5. If you have two floppy disc drives in your system, which one receives the drive letter A:?

   A. The drive jumpered for master

   B. The drive connected to the primary floppy drive controller

   C. The drive in the middle of the floppy cable

   D. The drive at the end of the floppy cable

6. Which type of flash memory card is currently the oldest?

   A. CompactFlash

   B. Memory Stick

   C. Secure Digital

   D. SmartMedia

7. Which device allows your computer to read flash memory cards?

   A. Scanner

   B. Card reader

   C. Floppy drive

   D. ZIP drive

8. AutoPlay reads which of the following files when an optical disc is inserted?

   A. autoplay.inf

   B. autorun.inf

   C. autorun.ini

   D. autorun.exe

9. The contents of an optical disc can be saved as what kind of file?

   A. ISO

   B. ISO-9660

   C. INF

   D. CDDA

10. Both CD and DVD drive speeds are based on multiples of the original CD-ROM drive speed. What is that speed?

    A. 100 KBps

    B. 150 KBps

    C. 100 MBps

    D. 150 MBps

11. You are looking for a CD-RW drive that can write CD-Rs at 48×, read CDs at 52×, and write CD-RWs at 32×. Which of the following answers meets your specifications?

    A. 52×48×32×

    B. 32×48×52×

    C. 48×32×52×

    D. 48×52×32×

12. What settings in the CMOS setup must you change to install an optical drive?

    A. Number of heads and cylinders the drive has

    B. Whether the drive is installed on the primary or secondary IDE channel

    C. Whether the jumpers on the drive are set to master or slave

    D. None, because an optical drive is not configured through the CMOS setup

13. What type of DVD can store 15.9 GB of data or more than eight hours of video?

    A. Double-sided, single-layered

    B. Single-sided, single-layered

    C. Single-sided, dual-layered

    D. Double-sided, dual-layered

14. Which of the following kinds of discs is the best choice for performing regular backups?

    A. CD-ROM/XA

    B. CD-Interactive (CD-I)

    C. CD-R

    D. CD-RW

15. While studying abroad, you purchased brand-new Blu-ray Discs produced in China. After returning to the United States, you find they will not work in your Blu-ray Disc player. What is most likely the problem?

    A. The Blu-ray Discs have a C region code.

    B. The Blu-ray Discs have a 6 region code.

    C. The Blu-ray Discs have a B region code.

    D. The Blu-ray Discs have an A region code.

■ Essay Quiz

1. Why do many manufacturers build computers without floppy drives? If you bought a new computer, would you still want a floppy disk drive in it? Write a short essay defending or attacking the floppy drive.

2. You have been tasked to provide removable media for each of the technicians in your department. One tech wants a card reader and SD cards, and another wants a USB thumb drive. Write a memo outlining the advantages of each technology and make a recommendation.

3. Your friend Jack's hard drive died last week, so he bought a new hard drive and installed it. Now he's trying to install Windows XP, but his computer will not boot to the CD-ROM drive. He's called you for help. What does he need to do to get his computer to recognize and boot to the CD-ROM drive so he can install the OS?

4. Your department is getting ready to replace the old computers, and your boss Mrs. Turner has asked you to investigate what kind of optical drives the new computers should have. Write a memo to your boss listing the device(s) you have selected and justifying your choice(s).

5. Your friend Dudley wants to burn high-definition movies on his desktop system, which currently only has a CD-RW drive. He eventually wants to play back the movies with the highest possible picture quality on his brand-new HDTV. What kind of technology and other considerations would you suggest to Dudley to achieve his goal?

Lab Projects

• Lab Project 13.1

If your lab PC has a floppy disk drive, install a second floppy disk drive. How does your system determine which is drive A: and which is drive B:? Reverse the ribbon cable on the A: drive so the red stripe no longer aligns with pin 1. What happens when you boot the system back up? Can the drive read disks in this condition?

• Lab Project 13.2

Flash media comes in a bunch of different forms. Take a trip to your local computer store—or even to a drugstore that has digital picture processing—and see what sort of media or flash devices they have available. What are some of the advantages or disadvantages of one form factor over another?

• Lab Project 13.3

Use the Internet to check these sites: www.compaq.com, www.dell.com, and www.gateway.com. What kinds of optical drives do these companies offer with their new computers? Do any of the companies offer multiple optical drives? If so, which ones and what devices? What upgrades for optical drives do the companies offer and how expensive are the upgrades? If you were buying a new PC, which optical drive(s) would you want on your computer? Why?

• Lab Project 13.4

Adding a second optical drive to a PC enables you to do some fun things, from making your own music CDs to watching movies. Assuming you want to install a PATA drive, you then need to face some issues. Which controller should you use, primary or secondary? Should both optical drives be on the same controller or on different controllers? Why?

Most techs would install a burner as secondary master and put a read-only drive on the primary as slave, but different drives require different consid-

erations. If you don't plan to copy CD to CD, there's no reason the read-only CD shouldn't be secondary slave. The key is you have to experiment.

Install a second optical drive—preferably a burner—and run it through its paces. Copy files and burn discs to and from the optical and hard drives. Then change the configuration of your drives (such as having both optical drives on the same controller) and run through the testing process again. Do you notice any differences?

• Lab Project 13.5

Use a map of the world, an atlas, or a globe. See if you can identify the three assigned Blu-ray region code areas. (Hint: The codes are A, B, and C.) Next, see if you can identify the specifically assigned DVD

region code areas. (Hint: The codes are 1, 2, 3, 4, 5, and 6.) Next, using Windows XP, Vista, or 7, look under the hardware properties of your DVD or Blu-ray Disc player to identify your region code.