CHAPTER 13

Removable Media

In this chapter, you will learn how to

- Explain 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 personal PC since its first introduction back in 1980. Granted, back then the only removable media available were 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 personal computer. 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 have so many other uses that this hasn't slowed things down a bit. 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. For the sake of organization, all removable media are broken down into these groups:

- **Floppy drives** The traditional floppy drive
- **Flash memory** From USB thumb drives to flash memory cards

Figure 13-1
Author's toolbox

- **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 21, "Portable Computing," whereas tape backups are part of the big world of backups and are covered in Chapter 17, "Maintaining and Troubleshooting Windows."

Historical/Conceptual

Floppy Drives

Good old floppies! These little disks, storing a whopping 1.44 MB of data per disk, have been part of PCs from the beginning. For decades, the PC industry has 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.

Only in the past few years have we finally seen systems without floppy drives due 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 floppy drives (interesting how long it took to start being adopted by PC makers). Thus, the venerable floppy drive will probably soon disappear from PCs. Until then, the floppy drive, that artifact from the Dark Ages of the PC world, will continue to be a viable technology you must know.

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 current floppy disks are 3½ inches wide and store 1.44 MB (Figure 13-2). You use a *3½-inch floppy drive* to access the contents of the disk.

Figure 13-2 Floppy drive and floppy disk

Whenever your system accesses a floppy disk in its floppy drive, a read/write LED on the outside front of the drive flashes on. You should not try to remove the floppy disk from the drive when this light is lit! That light means that the read/writes heads are accessing the floppy drive, and 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.

NOTE 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.

The first PC floppy drives used a 5¼-inch floppy drive format (Figure 13-3). The 5¼-inch measurement actually described the drive, but most users also called the disks for those drives 5¼-inch disks. In the 1970s and early 1980s, before PCs became predominant, you would occasionally see an 8-inch format floppy drive in computers. Fortunately, these

Figure 13-3
A 5¼-inch floppy drive and disk

never saw any noticeable use in PCs. If you happen to run into an 8-inch drive or disk, keep it! Collectors of old computers pay big money for these old drives.

Around 1986, the 3½-inch drives appeared and, within a few years, came to dominate the floppy world completely. Today, both 3½-inch and 5¼-inch floppy drives have mostly been replaced by CD and DVD burners and USB flash drives. If you are really interested, however, you can still purchase these drives on the Internet or special-order a custom-built system complete with floppy drives pre-installed.

Essentials

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, many system makers have dropped the twist and saved a couple of pennies on a simpler cable (Figure 13-4).

By default, almost all PCs (well, the ones 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.

Figure 13-4 Floppy cable for only one drive

Inserting Ribbon Cables

Look at the floppy cable in Figure 13-4. 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 13-5. Notice how clearly the motherboard has *pin 1* marked in Figure 13-5. 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.

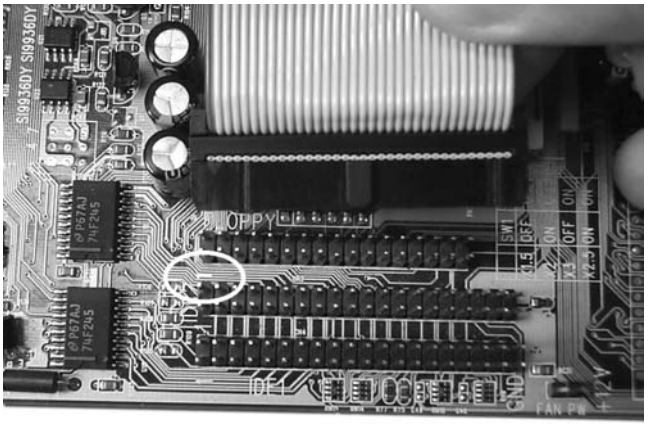

Figure 13-5 Plugging a floppy cable into a controller, pin 1 labeled at left

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 (Figure 13-6).

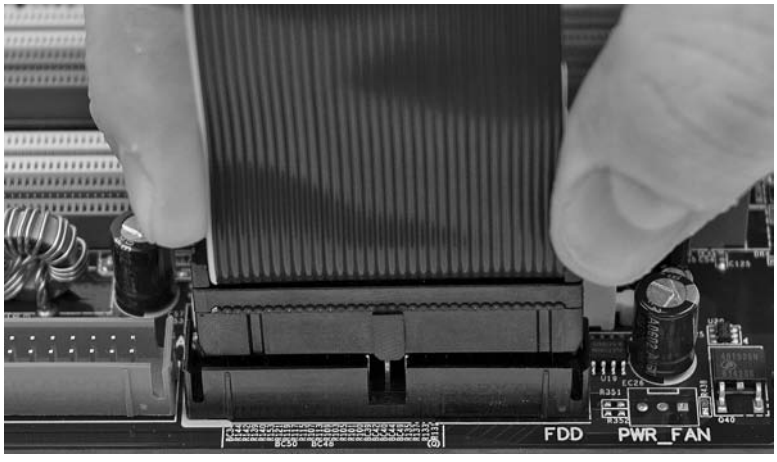

Figure 13-6 Floppy controller with notch

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.

EXAM TIP 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.

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 (Figure 13-7). If you're installing only one floppy, make sure you install it in the A: drive position.

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 13-8, a bottom view of a properly installed mini connector—note the chamfers (beveled edges) that show correct orientation. The problem lies in the plastic used to make the connector.

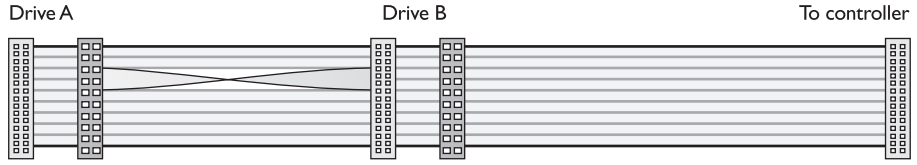

Figure 13-7 Cable placement determines the drive letter.

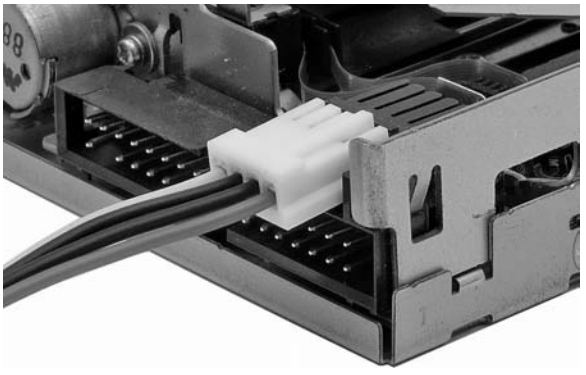

Figure 13-8 Properly installed mini connector

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.

CAUTION Installing *any* power connector incorrectly will destroy whatever device is unfortunate enough to be so abused. However, with the exception of minis, most power connectors are constructed so that it's almost impossible to do so unintentionally.

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 13-9 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.

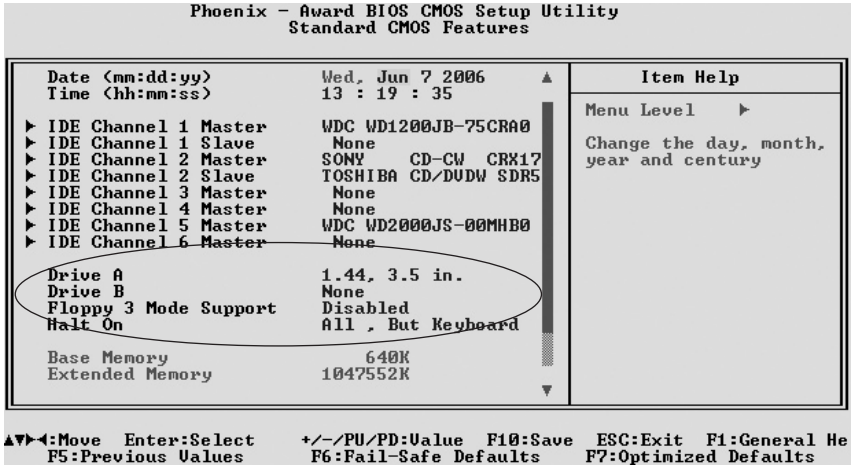

Figure 13-9 CMOS setting for one standard floppy drive

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 (Figure 13-10).

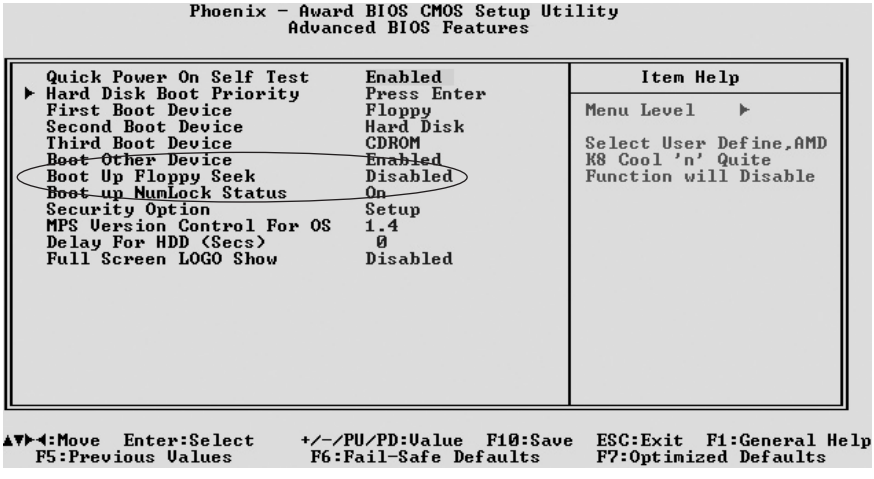

Figure 13-10 CMOS Boot Up Floppy Seek option

Many CMOS setup utilities have an option called Floppy 3 Mode Support. Refer to Figure 13-9 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.

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, PDAs, 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, and even more so since digital photography and multimedia storage have littered hard drives with huge files that won't fit on a single floppy disk. The latest entry into the floppy disk replacement sweepstakes is a winner: the USB Flash memory drive, also known as the *USB thumb drive*, jump drive, or flash drive. These tiny new drives are incredibly popular (Figure 13-11). For a low price in US$, you can get an 8 GB thumb drive that holds as much data as 5600 standard 3½-inch floppy disks.

Figure 13-11
USB thumb drives

The smallest thumb drives are slightly larger than an adult thumbnail; others are larger and more rounded. The drives are hot-swappable in Windows 2000/XP/Vista. 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. One big improvement over floppies is cross-platform compatibility—you can transfer files among Macintosh, Windows, and Linux operating systems.

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. At this point there's no single magic USB thumb drive to recommend, because bootable USB drives are still quite new, and updated versions come out almost daily. If you just have to try this new technology now, check out the GParted LiveUSB at http://gparted.sourceforge.net and click on the Live CD/USB/PXE link.

Flash Cards

Flash cards are the way people store data on small appliances. Every digital camera, virtually every PDA, and many cell phones 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 (Figure 13-12). Roughly one inch wide, CF cards use a simplified PCMCIA bus (see Chapter 21, "Portable Computing," 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.

Figure 13-12
CF card

Clever manufacturers have repurposed the CF form factor to create the microdrive (Figure 13-13). *Microdrives* are true hard drives, using platters and read/write heads that fit into the tiny CF form factor. Microdrives 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

Figure 13-13
Microdrive

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 (Figure 13-14). The introduction of SD media reduced SmartMedia's popularity, and no new devices use this media.

Figure 13-14
SmartMedia

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 comes in two types: the original SD and SDIO. SD cards store only data. The more advanced SDIO (the "IO" denoting input/output rather than storage) cards also support devices such as GPSs and cameras. If you want to use an SDIO device, you must have an SDIO slot. There is no way to tell an SD slot from an SDIO slot, so read the technical specs for your device!

SD cards also come in three tiny forms called *SD*, *Mini Secure Digital* (*MiniSD*), and *Micro Secure Digital* (*MicroSD*) cards. They're extremely popular in cellular phones that use flash memory, but see little use in other devices. Figure 13-15 shows the three forms of SD cards.

Figure 13-15 SD, MiniSD, and MicroSD cards

NOTE 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.

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 (Figure 13-16). There are several Memory Stick formats, including Standard, Pro, Duo, Pro Duo, and Micro.

Figure 13-16 Memory Stick

xD Picture Card

The proprietary *Extreme Digital* (*xD*) *Picture Cards* (Figure 13-17) 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!

Figure 13-17
xD card

Card Readers

Whatever 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 (Figure 13-18), and some PCs, especially those tuned to home theater use, often 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 the usually proprietary USB cable along, you could connect the camera

Figure 13-18
USB card reader

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 as well as copy, paste, and rename files.

Optical Drives

CD-, DVD-, and Blu-ray Disc–media discs and drives 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 20 years ago as a replacement for vinyl records. The CD now reigns as the primary method of long-term storage for sound and data. 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 and may very well supersede DVD in the future as the high-definition video and data storage war wages on.

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. 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 13-19).

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

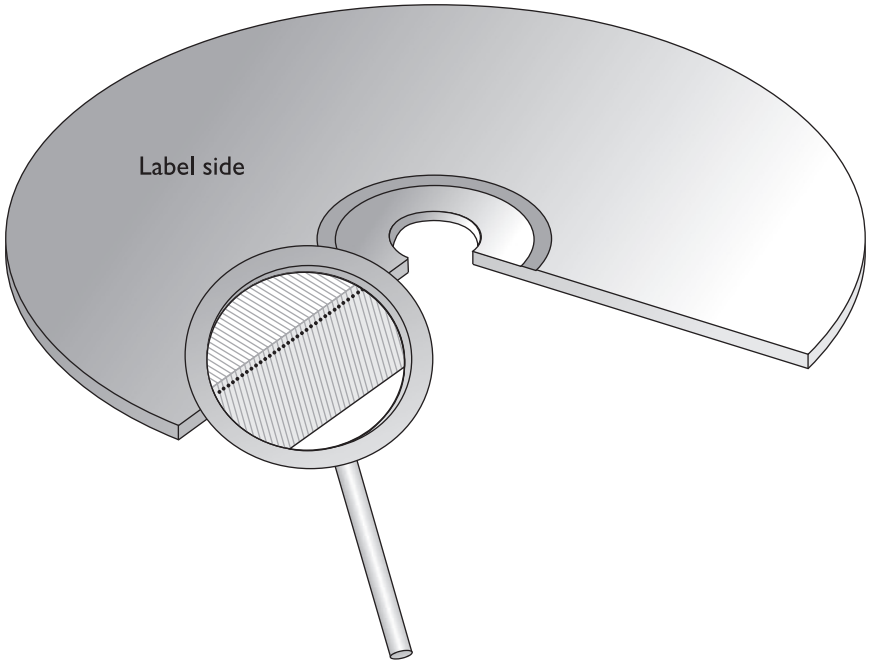

Figure 13-19 Location of the data

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 zeroes. 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-I, CD-ROM/XA, 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 (Figure 13-20). 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.

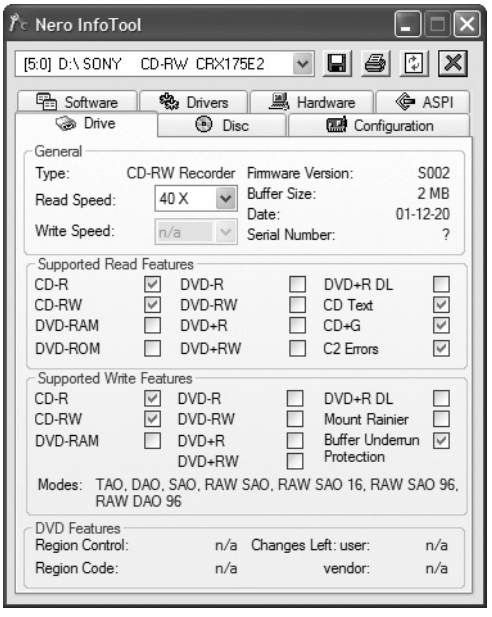

Figure 13-20 Crazy CD formats

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 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. It's important to know these ISO-9660 extensions:

- **Joliet** Microsoft's extension of the ISO-9660. Macintosh and Linux also support Joliet formatted discs.

- **Rock Ridge** An open standard to provide UNIX file system support for discs; rarely used outside of UNIX systems.
- **El Torito** Added support to enable bootable CD-media. All bootable CDs use the El Torito standard, which is supported by the BIOS on all modern PCs.
- **Apple Extensions** Apple's added support for their HFS file system. Windows systems cannot read these CDs without third-party tools.

It is important to appreciate that all of these file systems are extensions, not replacements for ISO-9660. That means a single CD/DVD can have both regular ISO-9660 information and the extension. For example, it's very common to have a CD-media that is ISO-9660 and Joliet. If you place the CD into a device that cannot read Joliet, it will still be able to read the ISO-9660 information.

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:

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× 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!

CD-R

Making CD-ROMs requires specialized, expensive equipment and substantial expertise, and 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 13-21). 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.

Figure 13-21 A CD-R disc, with its capacity clearly labeled

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

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; more CD-R discs are burned now than ever before. 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.

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 working on content for the CD that accompanies this book, however, I may decide to delete an item; 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 13-22 shows all three formats.

Figure 13-22 CD-ROM, CD-R, and CD-RW discs

CAUTION 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.

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.

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 (Figure 13-23).

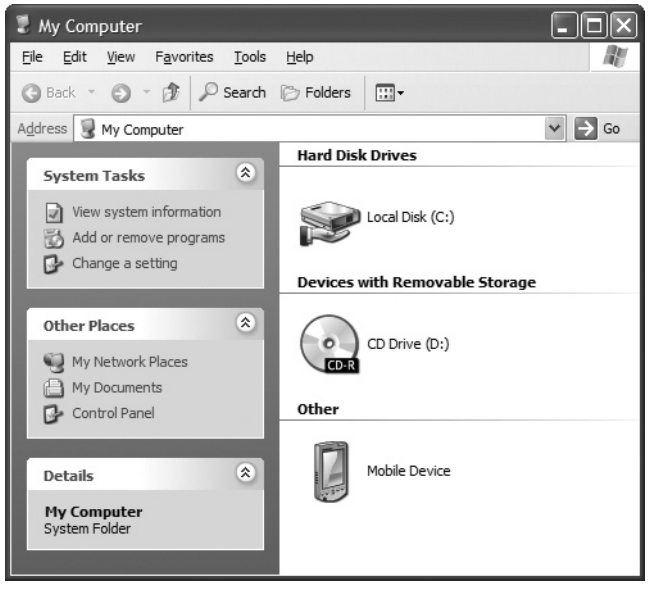

Figure 13-23 CD-media drive in Windows

NOTE More on installation and ATAPI compliance later in this chapter.

Windows displays an optical drive in My Computer or Computer with the typical optical drive icon and assigns it a drive letter. If you want to put data on a CD-R disc, however, you need special *burner software* to get that data onto the disc. Windows XP comes with burning support—you just drop a CD-R disc into your CD-RW drive, open the drive in My Computer, drag the files you wish to copy, and click Write to Disc. Also, Windows Media Player versions such as 9, 10, and 11 enable you to create music and data CDs within Windows XP. With Windows Vista, you can burn music and data directly to disc. Just put your CD-R into your CD-RW drive and, if AutoPlay is set to detect blank CDs, the OS presents you with the options to burn an audio CD by using Windows Media Player or to burn files to disc by using Windows. Almost every new CD-RW drive comes with some type of burner software as well, so you rarely need to go out and buy your own unless you have a preference for a particular brand. Figure 13-24 shows the opening menu of one that I like, the popular Nero optical disc burning program.

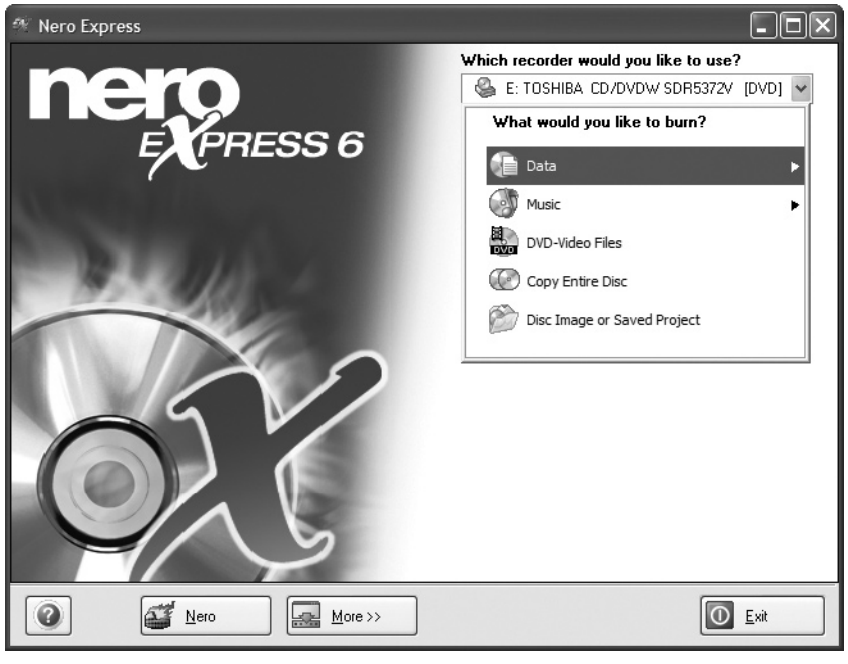

Figure 13-24 Nero optical disc burning program

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 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 quickly 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 13-25), 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

Figure 13-25 Typical DVD-video

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.

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

DVD-Video

The most beautiful trait of DVD-video lies in 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 distribute DVD movies on DS media with a 4:3 ratio on one side and 16:9 ratio on the other. 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). Let's detour into MPEG standards for a moment and then dive back into DVDs.

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 zeroes 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 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 2 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-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-R 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 (Figure 13-26). DVD-RAM is still around but fading away.

Figure 13-26
DVD-RAM disc

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 $250 (US) 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.

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 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 (Figure 13-27). 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.

Figure 13-27 Standard Blu-ray Disc

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

Table 13-2 Standard and Mini Blu-ray Disc Comparison Chart

Unlike with DVD discs, Blu-ray Disc offers no option at this time of a double-sided disc. I wouldn't be surprised to see this option in the coming years.

NOTE 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.

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 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 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 13-28 shows a Blu-ray Disc drive.

Figure 13-28 A combination CD/DVD/Blu-ray Disc drive

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

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* (rewritable) several times. There are also BD-R and BD-RE versions of mini Blu-ray Discs.

Blu-ray Burners

Most Blu-ray Disc burners cost a lot (at the time of this writing) and are out of the price range for the average consumer, but they 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 Hi-Speed USB 2.0, FireWire, or eSATA or internally through PATA, SATA, SCSI, or USB connections. Operating systems such as Windows 2000, XP, 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 manufactured 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, i8× 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 Blue-ray Discs.

Installing Optical Drives

From ten feet away, optical drives of all flavors look absolutely identical. Figure 13-29 shows a CD-RW, DVD, and BD-R drive. Can you tell them apart just by a glance? In case you were wondering, the CD-RW is on the bottom, the DVD is next, and finally the BD-R 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 13-30).

Connections

Most internal optical drives use PATA or SATA connections 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 the same way you would install any ATA hard drive. Figure 13-31 shows a typical DVD installation using PATA. The DVD is configured as slave with a master hard drive on a system's primary IDE controller.

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

Figure 13-29
CD-RW, DVD, and BD-R drives

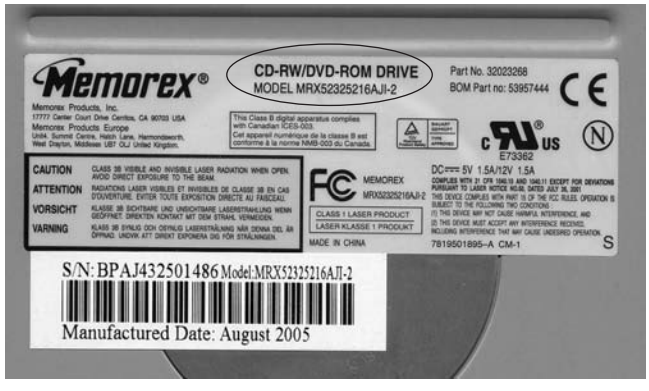

Figure 13-30
Label on optical drive indicating its type and speeds

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, giving techs a degree of assurance that they configured and installed the drive correctly (Figure 13-32).

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 two most common expansion options, I prefer FireWire simply because it's the standard for most digital video cameras, and its 400-Mbps *sustained* data transfer rate easily trumps the Hi-Speed USB 480-Mbps burst rate for transferring huge files.

Figure 13-31 Typical DVD installation

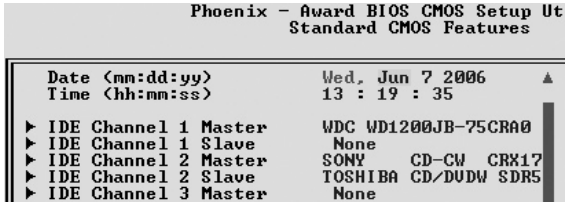

Figure 13-32 Autodetect settings for two optical drives

The only benefit to the USB versions is that USB is still more common than FireWire, particularly on portable computers. In fact, quite a few super-light laptops don't have an optical drive built in; the only way to load an OS on them is through an external drive. If you can't decide which expansion type to use, several manufacturers have taken pity on you.

You won't find any 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 Hi-Speed USB connections. If you have the choice, there is no choice. Choose eSATA every time.

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 the My Computer icon and verifying that a DVD drive is present (see Figure 13-33). When you want to know more, go to Device Manager.

The Device Manager contains most of the information about the DVD drive. 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.

Figure 13-33 DVD drive letter in My Computer

Auto Insert Notification

Another setting of note is the Auto Insert Notification option, often referred to as *AutoPlay* in Windows 2000/XP/Vista. This setting enables Windows to detect automatically the presence of audio or data optical discs when they are placed in the drive.

Windows 2000, Windows XP, and Windows Vista all have very different ways of dealing with AutoPlay. In Windows 2000, if the CD is an audio disc, track 1 plays automatically. If the CD-ROM is a data disc, Windows searches the disc's root directory for a special text file called *AUTORUN.INF*.

Although handy, the AutoPlay option can sometimes be annoying and unproductive. Windows 2000 does not provide a simple method to turn off AutoPlay. The only way to turn it off is to edit the Registry. You can use the REGEDT32 version of the Registry Editor and do it directly. In REGEDT32, access this subkey:

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Cdrom

Change Autorun 0 × 1 to 0 × 0.

Most techs use Group Policy to make the change because it gives you much more control in multiple optical drive situations. With Group Policy, you can turn off AutoPlay on your CD-RW drive, for example, but leave it enabled for your DVD drive. Group Policy

is a powerful tool that goes well beyond CompTIA A+, so be careful with what you're about to do. To run Group Policy, go to Start | Run and type **gpedit.msc** in the Run dialog box; or in Vista, just go to Start and type **gpedit.msc** in the Start Search text box. Click OK to open the MMC. To turn off AutoPlay, navigate down in the menu to the left as follows: Local Computer Policy | Computer Configuration | Administrative Templates. Select the System option and you'll see the *Turn off Autoplay* option in the Setting section on the right pane of the MMC (Figure 13-34).

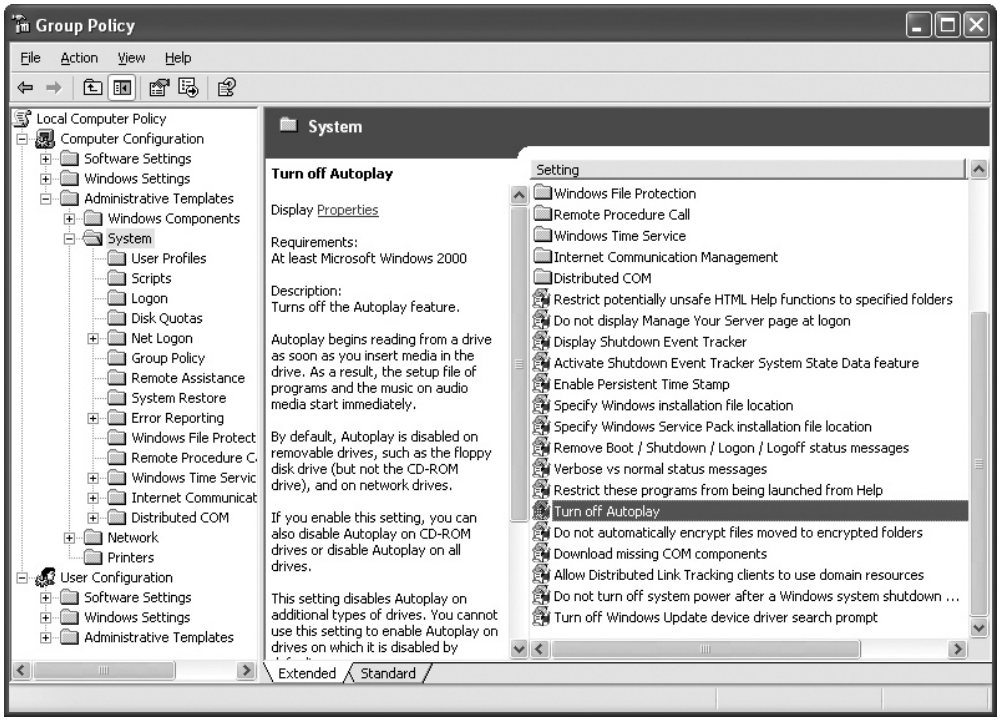

Figure 13-34 Group Policy MMC with *Turn off Autoplay* selected

Double-click or right-click *Turn off Autoplay* to open the Properties. Note in Figure 13-35 that the default option is Not Configured, but you can enable or disable it here. The words are messy here, so make sure you know what you're doing. *Enabling* Turn off Autoplay gives you the option to stop an optical device from automatically playing a disc. *Disabling* Turn off Autoplay prevents you or any other user from stopping any optical-media device from automatically playing a disc. Got the distinction?

Windows XP provides a much more sophisticated and simpler approach to AutoPlay. By default, when you insert a CD- or DVD-media disc that doesn't have an AUTORUN .INF file, XP asks you what you want to do (Figure 13-36). You can change the default

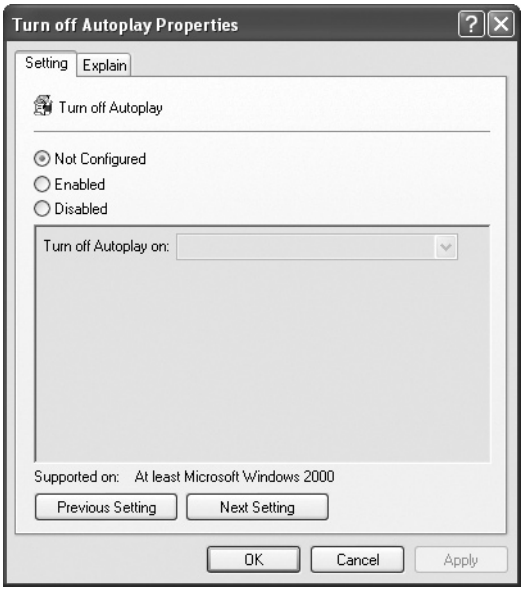

Figure 13-35
Turn off Autoplay Properties dialog box

Figure 13-36
XP prompting user for action

behavior simply by accessing the properties for a particular drive in My Computer and making your selection on the AutoPlay tab. Figure 13-37 shows some of the options for a typical Windows XP machine.

AutoPlay in Windows Vista is much more robust and offers many more options than in Windows 2000 or 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.

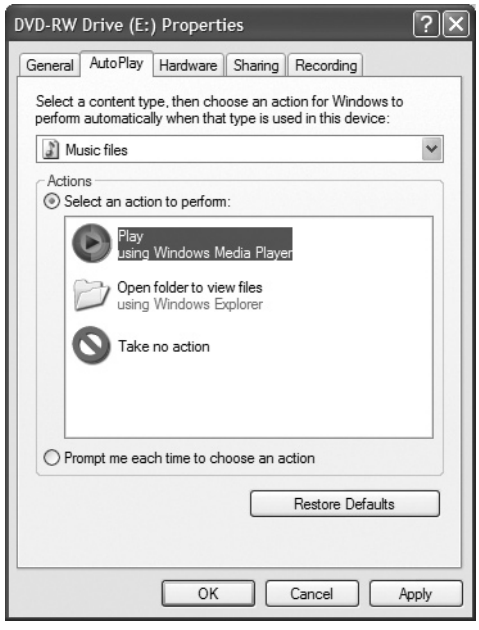

Figure 13-37 AutoPlay tab for a CD-RW drive

If a DVD movie is detected, you can tell AutoPlay to play the DVD by using PowerDVD 8 or some other program. You can adjust AutoPlay options in Windows Vista through Control Panel | Hardware and Sound | AutoPlay.

As a final note, in Windows 2000, XP, Vista, you can 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 (Figure 13-38).

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. DVD and Blu-ray Disc drives need software to enable you to watch movies, burn DVDs and Blue-ray Discs, and so on. As of this writing, Nero (www.nero.com) and Roxio Creator (www.roxio.com) share the reigns as the most popular CD-burning software programs. CyberLink PowerDVD and Corel WinDVD fight for Blu-ray Disc burning supremacy rights. If you're looking for a free burner, try CDBurnerXP Pro, pictured in Figure 13-39 (www.cdburnerxp.se). Windows XP contains basic CD-burning capabilities built into the operating system. With XP, you can readily drag and drop files to your CD-R or CD-RW drive and move those files from PC to PC. Almost all optical drives will read the discs burned in an XP system.

Windows Media Player makes an excellent DVD-watching application, but for DVD burning you need to turn to a third-party tool. Nero and Roxio make excellent software that handles every DVD recordable standard your drive can use (as well as CD-R and CD-RW).

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

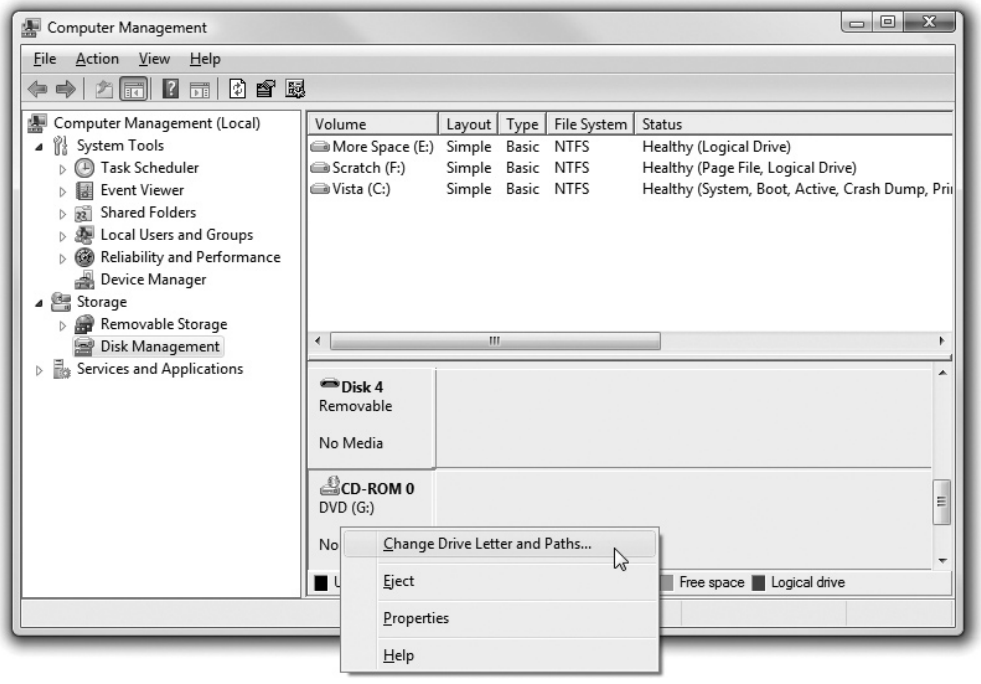

Figure 13-38 Change CD drive letter option in Disk Management

a complete copy—an ISO image as we say—of a CD or DVD. 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 CDs. For example, if you want a copy of the Ultimate Boot CD, you go to their Web site and download an ISO image. You then take your third-party burning program (Windows XP/Vista built-in burning software can't do this) 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.

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.

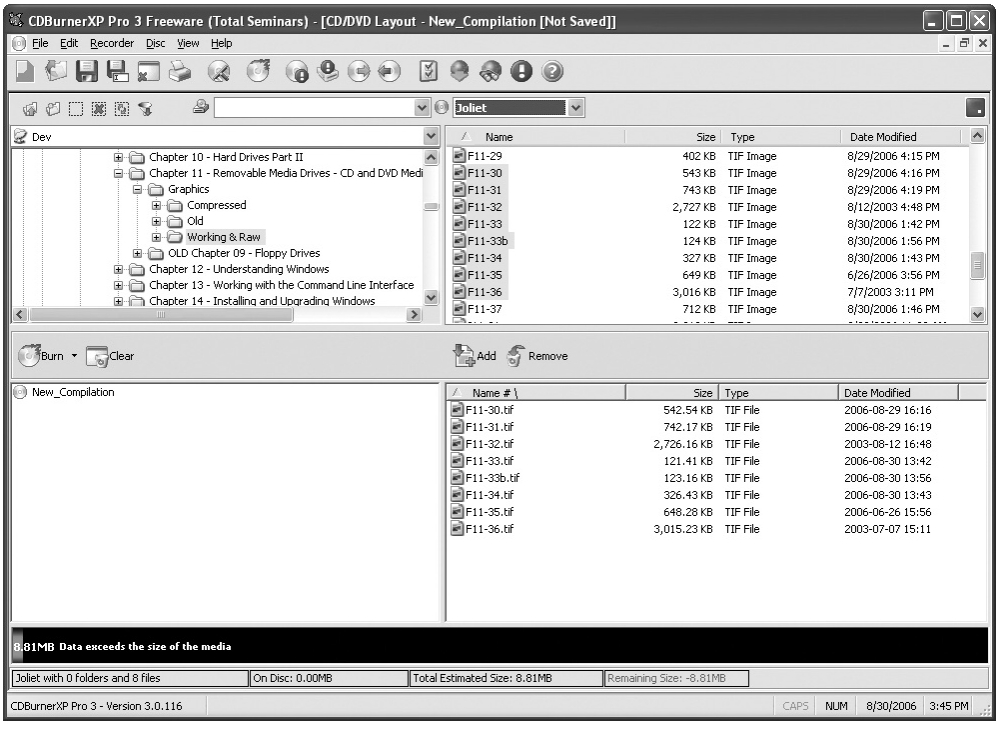

Figure 13-39 Typical third-party CD-burning program

- **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 Video 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. ATI and NVIDIA both offer Blu-ray Disc-compliant PCIe video cards with enough horsepower to get the job done.

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

EXAM TIP 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.

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. Today, most optical discs are sold *region free*, meaning you can play them anywhere. Many optical-media 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.

DVD Region Codes:

- **REGION 0** All regions
- **REGION 1** USA, 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, and their dependencies

Practical Application

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—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 a 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 13-40 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 or 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 a DVD-RW or any other writable DVD disc in your DVD drive or writable Blue-ray Discs in your Blu-ray Disc drive. Also, no optical drive will read badly scratched discs.

```
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 13-40 BIOS recognizing an optical drive at boot

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 13-41).

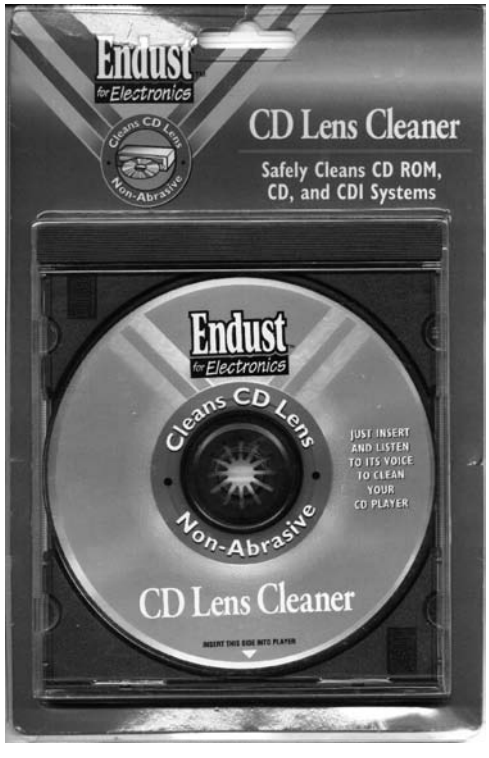

Figure 13-41 Optical-drive cleaning kit

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 Blue-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.

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 a 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. 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.

EXAM TIP 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 specifically on the 220-702 exam, so make sure you understand this information.

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.

Beyond A+

Color Books

The term *color books* is often used in the world of CD-media. 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, $3000 (US)—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

Blu-ray Disc Java

Blu-ray Disc Java (BD-J) is a program application environment based on Java ME (Java Platform, Micro Edition) that enables content providers to develop and deliver highly interactive Blu-ray Disc movies, games, and content to you. Most state-of-the-art (or state of the business) mobile devices, smart cards, and other gadgets use Java APIs (application program interfaces) to support requests made by the device, program, or operating system. BD-J APIs are used for similar purposes with Blu-ray Disc devices. They enable and detail the interaction of such things as fancy menus, downloaded games and content, and certain playback capabilities. If you play online games through your PlayStation®3 and HDTV, for example, you use BD-J in more ways than you probably know.

Chapter Review Questions

1. To install a floppy drive as the A: drive, what must you do?
   - **A.** Attach the mini connector.
   - **B.** Plug it into the end connector of the ribbon cable.

C. Plug it into the middle connector on the ribbon cable.

D. Attach the Molex connector.

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. Which term describes the capability to burn files to a CD-R and then come back later and burn additional files?

A. MultiBurn

B. Multisession

C. MultiDrive

D. Multibuffer

4. Which type of flash memory card is currently the most popular?

A. CompactFlash

B. Memory Stick

C. Secure Digital

D. SmartMedia

5. What type of device must be installed on your system so you can access data on a flash memory card?

A. Scanner

B. Card reader

C. Floppy drive

D. Zip drive

6. Which of the following can be bootable media? (Select the best answer.)

A. CD-R disc

B. Floppy disk

C. USB thumb drive

D. All of the above

7. When you insert a CD, the AutoPlay feature of Windows looks for what file?

A. AUTOPLAY.INF

B. AUTORUN.INF

C. AUTORUN.INI

D. AUTORUN.EXE

8. You can save a copy of a CD or DVD as what type of file?
   - **A.** ISO
   - **B.** ISO-9660
   - **C.** INF
   - **D.** CDDA
9. A CD-RW has a speed rating of 12×10×32×. What do the three numbers refer to, in order?
   - **A.** Write, rewrite, read
   - **B.** Read, write, rewrite
   - **C.** Rewrite, read, write
   - **D.** Write, read, rewrite
10. Which standard covers DVD-ROM technology?
    - **A.** MPEG-1
    - **B.** MPEG-2
    - **C.** MPEG-3
    - **D.** MPEG-4

Answers

1. **B.** Plug the floppy drive into the end of the ribbon cable to make it the A: drive.
2. **A.** If the floppy disk won't read in the drive, try another disk first.
3. **B.** The term *multisession* describes the capability to burn files to a CD-R and then come back later and burn additional files.
4. **C.** Secure Digital cards are the current kings of the marketplace.
5. **B.** You need some sort of card reader to read a flash memory card.
6. **D.** You can make a boot disk out of optical discs, floppy disks, or flash memory drives.
7. **B.** By default, Windows looks for AUTORUN.INF when you insert a CD.
8. **A.** You can save a complete CD or DVD as an ISO image.
9. **A.** The three speeds listed for CD-RW drives stand for write, rewrite, and read.
10. **B.** The MPEG-2 standard covers DVD-ROM technology (among other things).