CHAPTER 7

Exploring Printers

In this chapter, you'll learn about laser, inkjet, impact, and thermal printers. These are the four common types of printers you run across as an A+ technician. It's important to have a basic understanding of how they work so that you're better prepared to maintain and troubleshoot them. You'll also learn how printers are connected and the basic steps for installing and configuring printers.

Exam 220-801 objectives in this chapter:

- 1.12 Install and configure various peripheral devices.
  - Output devices
    - Printers
- 4.1 Explain the differences between the various printer types and summarize the associated imaging process.
  - Laser
    - Imaging drum, fuser assembly, transfer belt, transfer roller, pickup rollers, separate pads, duplexing assembly
    - Imaging process: processing, charging, exposing, developing, transferring, fusing and cleaning
  - Inkjet
    - Ink cartridge, print head, roller, feeder, duplexing assembly, carriage and belt
    - Calibration
  - Thermal
    - Feed assembly, heating element
    - Special thermal paper
  - Impact
    - Print head, ribbon, tractor feed
    - Impact paper
- 4.2 Given a scenario, install, and configure printers.
  - Use appropriate printer drivers for a given operating system
  - Print device sharing

- Wired
  - USB
  - Parallel
  - Serial
  - Ethernet
- Wireless
  - Bluetooth
  - 802.11x
  - Infrared (IR)
- Printer hardware print server
- Printer sharing
  - Sharing local/networked printer via Operating System settings
- 4.3 Given a scenario, perform printer maintenance.
  - Laser
    - Replacing toner, applying maintenance kit, calibration, cleaning
  - Thermal
    - Replace paper, clean heating element, remove debris
  - Impact
    - Replace ribbon, replace print head, replace paper

Exam 220-802 objectives in this chapter:

- 1.4 Given a scenario, use appropriate operating system features and tools.
  - Administrative
    - Print management
- 4.9 Given a scenario, troubleshoot printers with appropriate tools
  - Common symptoms
    - Streaks
    - Faded prints
    - Ghost images
    - Toner not fused to the paper
    - Creased paper
    - Paper not feeding
    - Paper jam
    - No connectivity

- Garbled characters on paper
- Vertical lines on page
- Backed up print queue
- Low memory errors
- Access denied
- Printer will not print
- Color prints in wrong print color
- Unable to install printer
- Error codes

- Tools
  - Maintenance kit
  - Toner vacuum
  - Compressed air
  - Printer spooler

Printing Basics

A printer is a peripheral device that provides you with a hard copy of your data. I'm betting that you've seen a printer in action, so that shouldn't be any surprise. However, you might not be aware of the different printer types. The following sections describe these in more depth, but briefly, here are basic descriptions of the various printer types:

- *Laser printers* use lasers to paint an electronic image onto a rotating drum. The drum then transfers the image to a piece of paper by using toner, which is then melted onto the paper. They are fast and produce a high-quality output but are the most expensive. Larger organizations commonly use them.
- *Inkjet printers* send little streams or jets of ink from the print head onto the paper. They are inexpensive and can produce vibrant color printouts, but the ink is expensive. Inkjet printers are very popular among home users and small offices.
- *Impact printers* create a printout using little pins that work like hammers to force ink from a ribbon onto paper. They are slow and noisy but are the only type of printer that can print the multipart forms used by some businesses.
- *Thermal printers* heat up the paper to print the output. They are used to print cash register receipts, ATM receipts, and lottery tickets.

EXAM TIP

You'll need to understand the basics of each of these printers. However, you'll find that the CompTIA exams focus heavily on laser printers.

Terminology

Printers use some common terminology and acronyms that are important to understand. These terms are used to describe the characteristics of the printer and help you determine their quality. Some of the common terms include the following:

- **PPM (pages per minute).** *PPM* identifies how quickly the printer can print. For example, laser printers can print between 10 and 100 PPM. Impact printers are much slower and are sometimes measured in characters per second (CPS) instead.
- **dpi (dots per inch).** The resolution or clarity of a printer is determined by *dpi*, or how many dots it can print per inch. This is often the same number vertically and horizontally. For example, a 600-dpi printer can print 600 dots in a 1-inch horizontal line and 600 dots in a 1-inch vertical line. 600 dpi is referred to as letter quality.

> ***NOTE*** **DPI RESOLUTION VALUE EXPRESSION**
>
> **Some printer specifications use two numbers, such as 600 × 600, to describe the resolution, but when the numbers are the same, you'll often see it as one number. That is, a 600-dpi printer implies a 600 × 600 dpi resolution. Some printers have a different horizontal and vertical resolution, and when they are different, you will always see them as two numbers. For example, some photo printers have a resolution of 2880 × 1440.**

- **Duplexing assembly.** Printers with a *duplexing assembly* can print double-sided print jobs. They flip the page so that the printer can print on the other side. Figure 7-1 shows an example of a duplexing assembly from an HP OfficeJet printer. It normally plugs into the back of the printer, but it's removed and turned over so that you can see the rollers. Printer settings often include a setting to enable or disable duplexing when two-sided printing is supported.

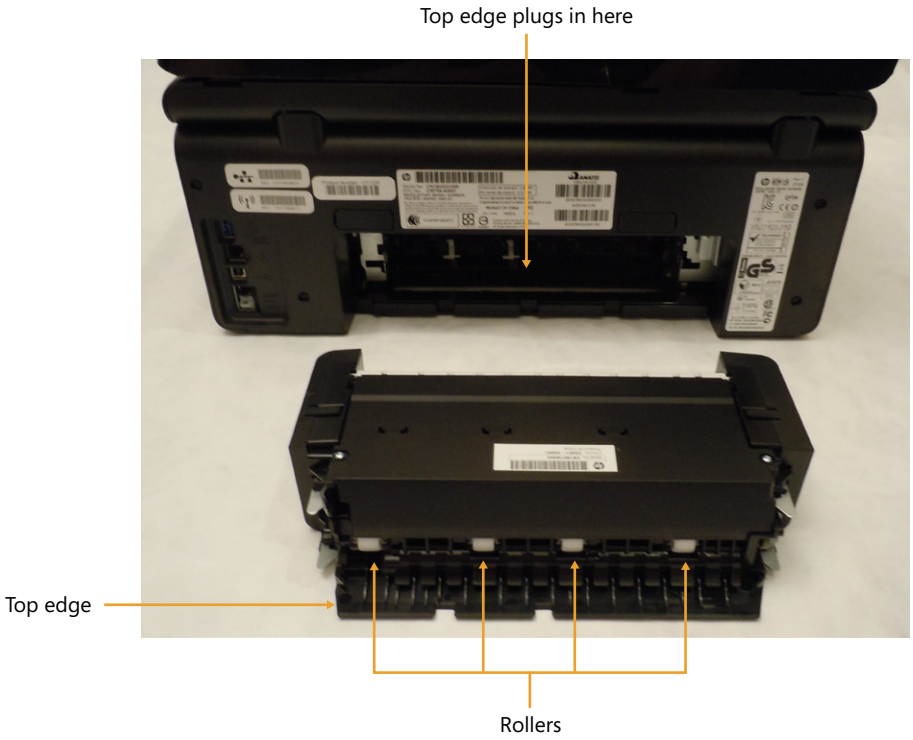


FIGURE 7-1 Duplexer on back of inkjet printer.

EXAM TIP

A duplexing assembly is required for printing two-sided print jobs. It is commonly found on laser printers and inkjet printers.

Paper

Paper comes in different types and forms, and printers covered in this chapter use the following types of paper:

- **Single-sheet paper.** Laser jet and inkjet printers use single-sheet paper fed into the printer from a *feeder* or a *paper tray*. Some general-purpose paper can be used in both laser jet and inkjet printers, but there are many higher-quality papers used to print better-quality color pages. Low-quality paper can cause printing problems such as paper jams or poor printouts. Printers commonly include sensors to indicate when the paper runs out.

MORE INFO **CHAPTER 5, "EXPLORING PERIPHERALS AND EXPANSION CARDS"**

Chapter 5 shows a picture of a multifunction printer in the scanners and digitizers section. That printer is an inkjet printer and it includes both a document feeder and a paper tray.

- **Continuous-feed paper.** This is also known as fan-fold or sprocket paper, or even paper with holes. The sheets are connected and include sprocket holes on each side of the paper. A *tractor feed* mechanism feeds the paper using these sprocket holes. Each sheet includes perforations so that you can separate the pages and the edges after printing. Continuous-feed paper is used by impact printers.
- **Thermal paper.** This is used by thermal printers. It is covered with a chemical that changes color when it is heated.

NOTE **PAPER RECOMMENDATIONS**

There is a wide assortment of paper types available for laser and inkjet printers. Manufacturers recommend the best paper to use for the printer in different situations. This is most important when printing color documents.

One of the biggest problems with paper occurs when it is exposed to high humidity. The paper won't actually be wet, but it can absorb the humidity from the air, making it more difficult for the printer to move it through the paper path. The result is more paper jams. Paper should be stored in locations that aren't subjected to high humidity and not opened until it's needed.

Common Maintenance Tools

One of the basic maintenance tasks with any type of printer is cleaning it, and there are several common tools you'll use, such as the following:

- **Compressed air.** You can use compressed air in a can or compressed air from a compressor. It's best to take the printer outside before blowing out the paper dust. This is the same type of compressed air discussed in Chapter 1, "Introduction to Computers."
- **Computer vacuum.** When you're working inside a building, it's not always a good idea to blow the dirt and dust out of a printer into the workspaces. Instead, you can use a vacuum. Regular vacuum cleaners can cause electrostatic discharge (ESD) damage, so only ESD-safe vacuums should be used.
- **Isopropyl alcohol.** Many of the rollers within a printer will get dirty, and isopropyl alcohol is an ideal choice to clean them. For example, Figure 7-2 shows the pickup roller in a laser printer used to pick up paper from a paper tray. When the pickup roller gets dirty, it can have problems picking up the paper. A benefit of isopropyl alcohol is that it evaporates quickly and doesn't leave any residue. You apply it to a cotton swab or lint-free cloth and then clean the roller.

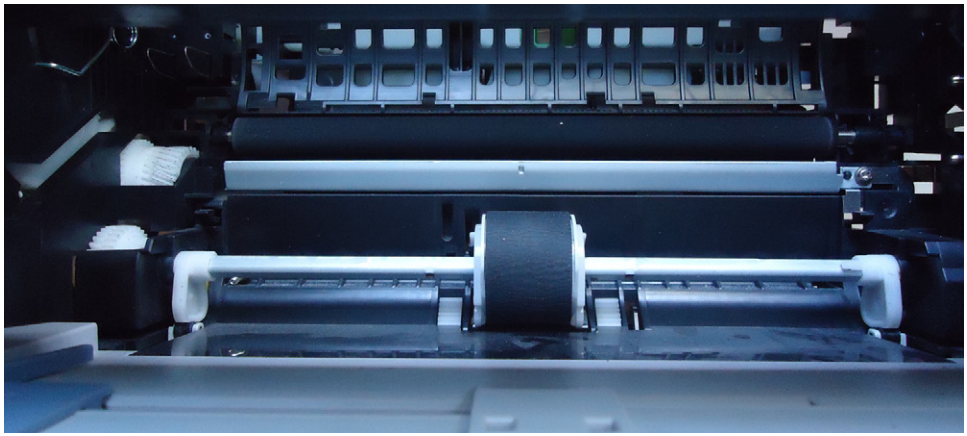


FIGURE 7-2 Pickup roller in an empty paper tray.

Quick Check

1. What is required to print two-sided paper?
2. What is used to clean printers?

Quick Check Answers

1. Duplexing assembly.
2. Compressed air, ESD-safe vacuums, and isopropyl alcohol.

Laser Printers

Laser printers provide a very high-quality output and are most commonly used in medium-to-large organizations that require fast, high-quality printers. They have become more affordable and are also used in small offices/home offices (SOHOs) and even by some individual users.

Laser Components

A laser printer includes several key components. The next section covers the laser imaging process in more detail, but the following are brief descriptions of these components:

- *Pickup rollers* are used to pick up a sheet of paper and begin feeding it through the printer.
- *Separator pads* work with the pickup rollers to ensure that only one piece of paper is picked up at a time.

- *Imaging drums* are round, rotating cylinders that are covered with a *photosensitive surface,* meaning it is sensitive to light. A laser uses light to write an image onto the drum.
- *Toner* is an extremely fine powder that includes carbon and plastic. It is electrically charged during the imaging process, causing it to stick to the drum where the laser wrote the image. Later in the process, it is transferred to the paper.
- *Transfer rollers* charge the paper. The image is transferred to the paper because the charged paper attracts the toner.
- *Fuser assemblies* heat the toner and melt into the paper.
- *Transfer belts* are used only on some high-end color laser printers. Colors are first applied to the transfer belt and then applied to the paper.
- A high-voltage power supply provides voltages as high as -1,000 VDC. This is used only in laser printers.

Chapter 1 described an uninterruptible power supply (UPS) used as a battery backup for systems. While an UPS is useful for computers, laser printers should not be plugged into an UPS. The high-voltage power supply draws a significant amount of power in a very short time and can damage an UPS.

Where should you plug in the laser printer? The best choice is to use a dedicated surge protector that does not have any additional equipment plugged into it. The next best choice is to plug it into a grounded wall outlet. It should not be plugged into a power strip shared by other devices.

Laser Imaging Process

As an A+ technician, you will very likely work with laser printers, so it's important to understand how they work so that you'll be better prepared to maintain and troubleshoot them. The laser imaging process includes seven stages or steps, and these steps work in a specific sequence as the imaging drum is rotating.

EXAM TIP

CompTIA A+ printing topics focus heavily on laser printers. When preparing for the exams, make sure you understand the seven steps of the laser printing process and how the different components are used within the printer. This will also help you with troubleshooting.

Figure 7-3 shows an overview of these stages, labeled as Processing, Charging, Exposing, Developing, Transferring, Fusing, and Cleaning. The following sections describe these steps in more depth.

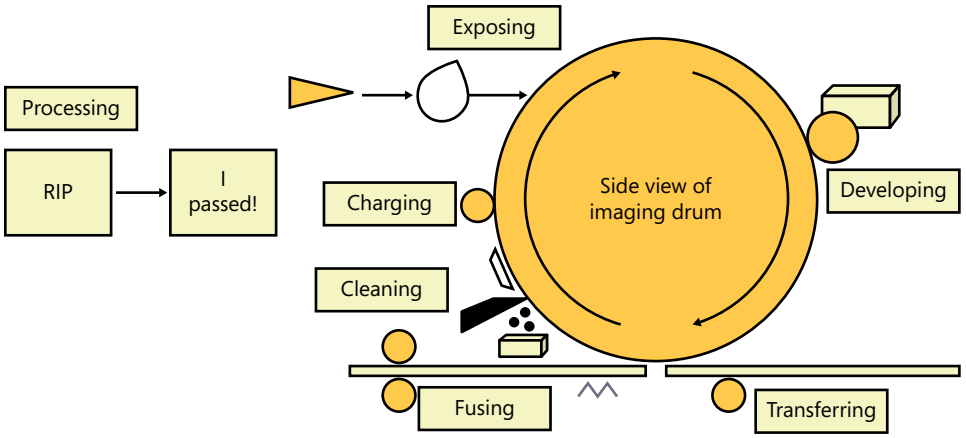


FIGURE 7-3 Laser imaging process.

Processing

The *processing* stage is also known as the raster image processing stage. A raster is a single line of dots, and a *raster image* is the combination of all the raster lines for a page. As you read this page, you perceive it as words and maybe a graphic. A laser printer identifies the page as a raster image of dots.

Consider a 600 × 600 dpi laser printer. For any given square inch of a sheet of paper, the raster image includes details about each of these 360,000 dots. These details include whether or not it should be printed, how light or how dark the dot should be, and, if it's a color printer, what color the dot should be.

Most laser printers include a *raster image processor (RIP)* that creates the raster image. The computer sends the print job to the printer in a format the RIP understands, and the RIP then creates the raster image.

Raster images can take up a lot of space. If you print pages using 600-dpi graphics, it takes about 4 MB of RAM per page to hold the raster image. If it's a color page, it takes about 16 MB of RAM per page. If the printer doesn't have enough space to hold the print job, it will often give a "low memory" or "out of memory" error message.

Charging

In the *charging* step, a primary charge roller applies a high-voltage negative charge to the imaging drum, as shown in Figure 7-4. In older laser printers, this was applied with a corona wire that was easily broken during maintenance, but most new laser printers use a primary charge roller. This voltage is typically between -500 and -600 VDC but can be as high as -1,000 VDC.

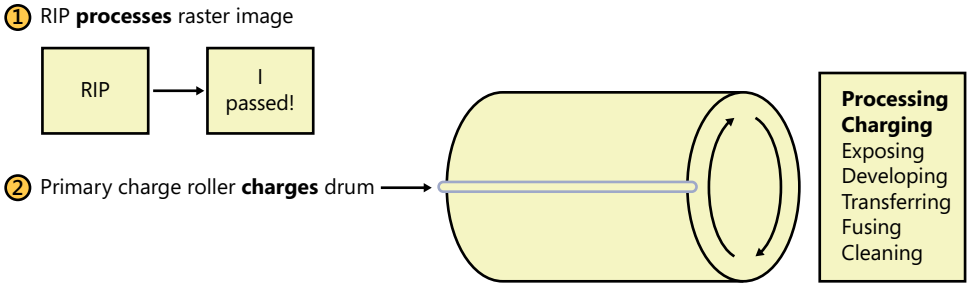


FIGURE 7-4 Charging the imaging drum.

This has two purposes. First, if there is any residual charge from a previous print job, it removes it. Second, it prepares the imaging drum to accept the image from the laser. Notice that even though the raster image is created, we aren't using it yet.

Exposing

After the drum has a uniform charge, the laser exposes the imaging drum with the raster image in the *exposing* stage. It does this by sending a highly focused laser beam through one or more mirrors and lenses, and when the beam hits the photosensitive drum, it neutralizes the charge applied in the previous step. However, it neutralizes the charge only where the laser beam hits the drum, as shown in Figure 7-5.

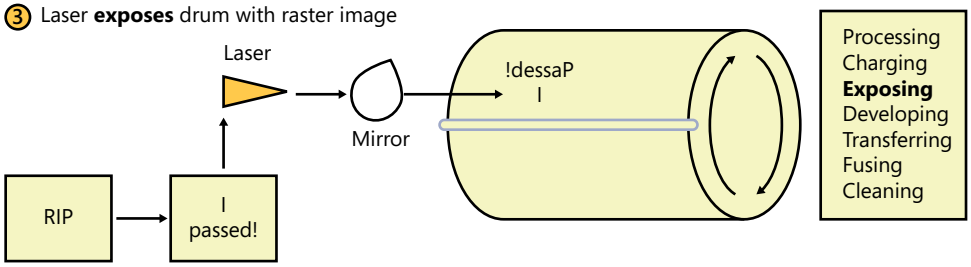


FIGURE 7-5 Exposing the imaging drum.

> ***NOTE*** **EXPOSING IS WRITING**
>
> **Some books refer to *exposing* as *writing*. You can think of it as the laser writing the image onto the drum. However, the CompTIA objectives specifically list it as exposing.**

At this point, the drum has a high-voltage negative charge everywhere except for where the drum has been exposed by the light beam. Anywhere the drum has been exposed, it has a neutral charge.

Developing

The toner is applied to the imaging drum in the *developing* stage. First the toner is given a negative charge. At this point, the imaging drum has a negative charge except for where the image has been exposed, and the toner also has a negative charge.

When dealing with electricity, like charges repel and opposites attract. Therefore, if you have two components with similar charges, they pull apart from each other, while two components with opposite charges are attracted to each other. In this case, the negatively charged toner is attracted to the exposed areas of the drum that have a neutral charge.

Figure 7-6 shows a side view of the imaging drum. Toner is in the toner cartridge, and the developer roller makes the toner accessible to the drum. As the drum rotates, the toner sticks to the drum where the image has been written to the drum.

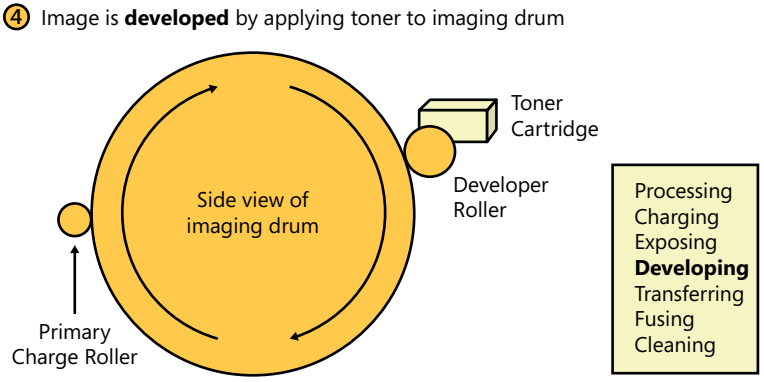


FIGURE 7-6 Developing the image.

There are many different types of toner and toner cartridges. For example, some manufacturers include the developer roller (sometimes called just the *developer*) in the toner cartridge.

Transferring

The toner is applied to the paper in the *transferring* stage. First, pickup rollers roll over the top of the paper in the paper tray to pick up a page. Separator pads roll the opposite way from underneath to ensure that only one sheet of paper is picked up. Next, a transfer roller (sometimes called a *transfer corona*) charges the paper, giving it an opposite charge from the toner. Just as the toner was attracted to the drum in the developing stage due to opposite charges, it will be attracted to the paper in this stage due to opposite charges. After the paper is charged, it's passed to the drum and the toner jumps to the paper, as shown in Figure 7-7.

Laser printers have a static charge eliminator that removes the static charge from the paper immediately after the image is transferred. You've probably noticed how socks stick together after you remove them from the clothes dryer. Similarly, the paper can stick to the drum if the static charge isn't removed.

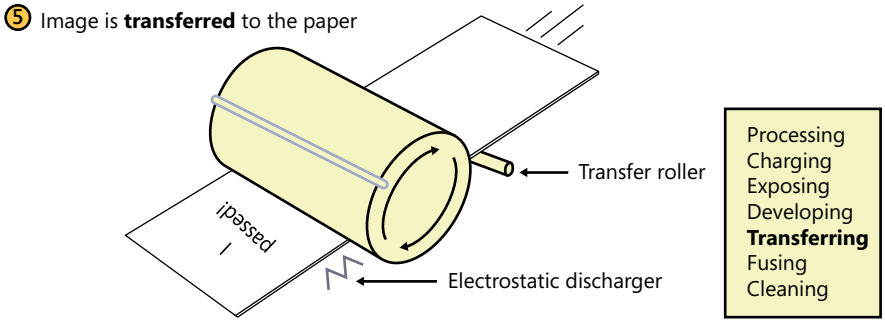


FIGURE 7-7 Transferring the image.

EXAM TIP

When preparing for the exam, it's important to know the steps in the laser imaging process and the order. For example, developing can occur only after exposing, and fusing can occur only after transferring.

Fusing

The toner isn't attached to the paper in the transferring stage. If you could pick it up and shake it, the toner would just fall off. The toner is fused to the paper in the *fusing* step. Toner is composed of carbon and plastic particles, and if you heat plastic, it melts. The fuser assembly heats the toner so that it melts into the paper.

Figure 7-8 shows how the paper is passed between two fuser rollers. One of the fuser rollers is heated, and the other fuser provides friction to press the toner into the paper as it is melted.

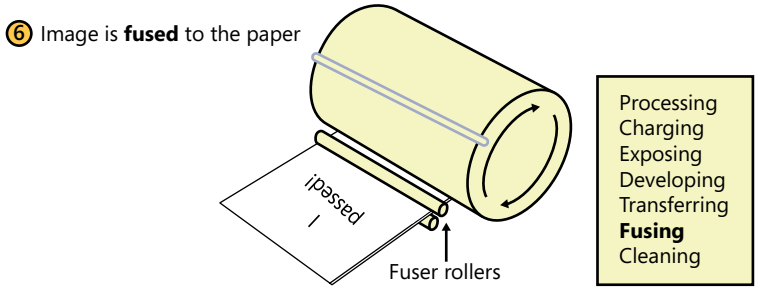


FIGURE 7-8 Fusing the image.

If you've ever taken a sheet of paper off a laser printer immediately after it printed, you've probably noticed that it's warm. That's not from the laser; it's from the melted toner.

NOTE **TRANSPARENCY PAPER MELTS**

Some speakers and teachers use transparency paper and overhead projectors during a presentation. They are especially useful for teachers who write on the transparency paper as they're teaching. However, the fusing assembly will melt most transparency paper. Only transparency paper specifically designed for a laser printer should be used in laser printers.

Cleaning

In the *cleaning* stage, excess toner is scraped off the drum and collected for disposal. The scraper is a small plastic or rubber blade that scrapes the toner off without damaging the drum. Next, an erase lamp neutralizes the charge on the drum, as shown in Figure 7-9.

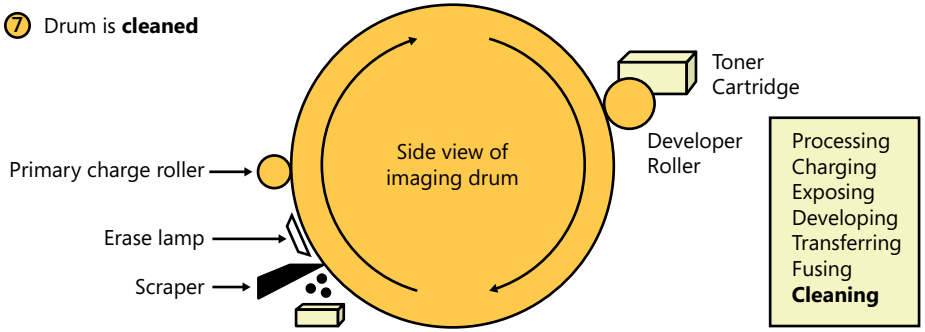


FIGURE 7-9 Cleaning the drum.

Notice that when the drum rotates clockwise, the primary charge roller is located after the scraper and the erase lamp. At this point the whole process can start again. Another image could be processed, charged, exposed, developed, transferred, and fused, and the drum can be cleaned to do it again.

What Comes First?

You might come across technical manuals that say that cleaning is the first step in the laser printer imaging process. This raises a logical question: What comes first?

A laser printer will typically start processing the next image before the current image is completed, so this is actually the first step. For example, after one image has been sent to the laser, the RIP can start processing the next image. Depending on how much memory a printer has, the RIP might be able to process several images in advance. However, if it first erased the image, it couldn't start until the current image had completed the printing cycle.

The drum must be cleaned before writing another image, and as long as this is done at the end of the last cycle, the process works. However, there are some special situations, such as a power loss, that can result in the last cycle not completing. Printers commonly include a

fail-safe process of cleaning the drum when a printer is first turned on or before doing a print job after the printer has been idle.

EXAM TIP

If you see a question that asks what the first stage in the laser printer imaging process is, look for "processing." Processing takes the longest and is often started before the previous image has completed. If "processing" is not an available answer, look for "cleaning."

Color Laser Printers

Most laser printers print only in black and white. Color laser printers are available but at a much higher cost. They can produce some vibrant images, but the imaging process is more complex than a typical laser printer. Laser printers use the CMYK color model of cyan (a blue-green or aqua color), magenta (a purplish-pink color), yellow, and black.

NOTE **CMYK AND RGB**

Primary colors are red, green, and blue. When you mix magenta and yellow, you get red. When you mix cyan and yellow, you get green. When you mix cyan and magenta, you get blue. When you mix cyan, magenta, and yellow, you get black. In contrast, when you mix red, green, and blue, you get white.

A color laser printer applies each of the four CMYK colors with varying intensity to create images. In some laser printers, these colors are applied to the paper in four separate passes. However, if the paper is slightly misaligned during any of these passes, it results in blurring and other color problems.

High-end color laser printers use a transfer belt to prevent these types of problems. They apply the four colors to the transfer belt in four passes and then transfer the image from the transfer belt to the paper in a single pass. The transfer belt is stronger than a piece of paper and less susceptible to misalignment issues.

Quick Check

1. **What are the seven stages of the laser printing process?**
2. **In what laser printing process stage is the image written onto the drum?**

Quick Check Answers

1. **Processing, charging, exposing, developing, transferring, fusing, and cleaning.**
2. **Exposing.**

Laser Printer Maintenance

Even though there are many different models of laser printers, you'll find that they share common maintenance tasks. This section covers these tasks and includes some important safety considerations.

Safety

One of the most important things to realize is that a laser printer includes a high-voltage power supply. Voltages are as high as -1,000 VDC and can be deadly. Stay safe and unplug the laser printer before performing any maintenance. Also, capacitors within a power supply can still hold a charge after a device is unplugged. Even after you unplug the printer, be careful of what you touch.

The fuser assembly melts the toner onto the paper and reaches a temperature of about 180 degrees Centigrade (about 356 degrees Fahrenheit). Even after you turn the printer off and unplug it, this will still be hot.

If the imaging drum is exposed during maintenance, you should be careful not to touch it. You can easily scratch it or leave a mark that won't be cleaned during a print cycle. These scratches or marks will appear on every printout until the drum is replaced.

IMPORTANT **DANGER OF INJURY OR WORSE**

A laser printer has potentially deadly voltages and extremely hot components within. You should turn it off and unplug it before servicing it.

Replacing Toner

As the toner runs low, the print quality of your printouts degrades. Also, most laser printers give software alerts letting you know that the toner is running low. The solution is simple: replace the toner.

NOTE **TONER CARTRIDGES**

In some laser printers, the toner cartridge includes the imaging drum, the developer, and/or a cleaning blade used to clean toner during the cleaning process. Therefore, when you replace the toner cartridge, you might also be replacing other components.

Different models have different procedures for replacing the toner, and it's important to follow the manufacturer's directions. The following are some general guidelines that apply to most toner cartridges:

- Instructions will usually direct you to shake the cartridge up and down and from side to side. This loosens the toner and helps ensure that you get full usage out the cartridge.

- Most toner cartridges include some type of seal to prevent the toner from leaking out. It's often a piece of tape or plastic that you remove prior to installing the new cartridge. If you don't remove it, your printouts will be blank.
- Be careful when handling the new toner cartridge. Ideally, you should the remove the new cartridge from the packaging and insert it immediately in the printer. This means that you have already removed the old cartridge.
- If the toner spills on you or someone else, consult the instructions or Material Safety Data Sheet (MSDS) to determine what to do. In general, you can wash it off with cold water. It's designed to melt, so you should not rinse it off with warm or hot water. If it spills on a desk, you can remove it with paper or cloth towels soaked with cold water.
- If you need to vacuum a toner spill, you should use a special vacuum with a high-efficiency particulate arresting (HEPA) filter. Without a HEPA filter, the toner particles might just blow right back into the air.
- Recycle the old cartridge. Many companies will purchase these. Companies refurbish them, fill them with toner, and sell them at a discounted cost.

Most laser toner cartridges include replacement filters and instructions about what should be cleaned. The high-voltage power supply creates a small amount of ozone, which is a gas that can be harmful in large amounts. Laser printers include an ozone filter to limit the danger from ozone, and it's common to replace this filter when replacing the toner cartridge. Other filters can usually be cleaned.

REAL WORLD **GETTING EXTRA PAGES FROM AN EMPTY TONER CARTRIDGE**

When the laser printer runs out of toner, it's usually not completely out. If you come across a printer that appears to have run out and you don't have a replacement toner cartridge available, you can usually use the following technique to get some printouts while you wait for the replacement to arrive.

Turn off the printer and remove the toner cartridge. Gently shake the cartridge from side to side and up and down. The toner is a very fine powder, and these actions release toner that has become stuck to the sides. After replacing the toner cartridge, you can usually print 20 or more pages without any problems

Be careful, though. Some toner cartridges have openings that stay exposed when you remove them. If you start shaking them, you might end up shaking toner all over yourself and the room.

Applying Maintenance Kit

When maintenance is required, many laser printers provide messages such as "Service Required" or "Perform Printer Maintenance." This message is normally timed to appear after the printer has printed a specific number of pages. Maintenance kits are available that include items such as pickup and separator rollers, transfer rollers, and fuser assemblies.

Sometimes you might notice that more than one sheet of paper is being pulled through at a time or that the paper is coming out crumpled. You might be able to clean the pickup and separator rollers to resolve the problem, or you might need to replace them with a maintenance kit.

Cleaning

It's often recommended to clean certain pickup rollers when replacing the toner. Isopropyl alcohol with a lint-free cloth or cotton swabs works best.

If the laser printer has a lot of paper dust buildup, you should use an ESD-safe vacuum to clean it. You should not use compressed air within a laser printer because you can potentially blow the dust into the imaging drum.

Calibration

Color laser printers have the potential to produce misaligned colors or lines. Many printers use a transfer belt to minimize this problem, but the problem can still occur. The solution is to run a calibration routine provided by the printer vendor. This will ensure that the printer heads are aligned.

Laser Component Replacement

Besides the toner cartridge and filters, many laser printer components can be replaced if they fail. You'll need to dig into the technical manual for the procedures, but it is possible. Figure 7-10 shows ace A+ technician José Vargas with a fuser assembly and a laser assembly that he has removed from a laser printer. The customer asked José to send him an update via text as soon as José had more information, and that's exactly what he's doing.

FIGURE 7-10 José texting a customer with information about a laser printer.

Quick Check

1. What precautions should you take before servicing a laser printer?
2. What else should be done when replacing the toner?

Quick Check Answers

1. Turn it off and unplug it.
2. Replace or clean the ozone filter and apply the maintenance kit.

Inkjet Printers

Inkjet printers can produce very high-quality color printouts and are very affordable. These two benefits make them very popular among home users and some SOHOs. They don't have as many serviceable parts within them, so you don't need to have a deep understanding of how they work to maintain them.

Figure 7-11 shows the basic components of an inkjet printer. One or more print heads are attached to a carriage and belt assembly, and this assembly moves the heads from side to side as the paper is fed through the printer. Ink cartridges can be attached to the print head or located elsewhere.

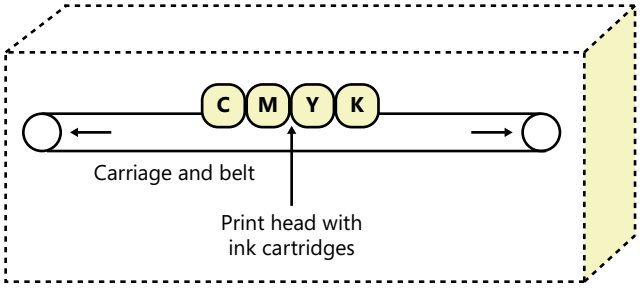


FIGURE 7-11 Basic components of an inkjet printer.

The carriage and belt assembly is controlled with a stepper motor and a pulley and usually includes a plastic guide and sensors. The sensors detect the position of the print head and paper. The assembly also includes a data cable connected from a printed circuit board to the print head.

While they are not shown in the figure, the printer will also have a paper feeder or paper tray where you insert the paper, and one or more rollers that pull the paper through the printer.

Many inkjet printers support duplexing assemblies so that they can print on both sides of the paper. The duplexing assembly shown in Figure 7-1 is from an inkjet printer.

The print speed of inkjet printers is relatively low when compared to a laser printer, but it is usually quick enough for most users. The primary drawback is the high cost of the ink.

Inkjet Ink Cartridges

Inkjet printers use the same CMYK model used by color laser printers. Some models use only two ink cartridges—one for all three CMY colors and another one for black ink. Other models use four cartridges, with separate cartridges for each CMYK color.

For example, Figure 7-12 shows the ink cartridges for an HP OfficeJet inkjet printer (on the left). They are accessible from the front panel to the left of the paper tray, and I've removed the black cartridge. Most people print black ink more than color, so the color ink cartridges are normally smaller than the black cartridge in any inkjet printer.

FIGURE 7-12 Ink cartridges.

For comparison, on the right in Figure 7-12, you can see a tri-color ink cartridge for another inkjet printer next to the Y inkjet cartridge from the printer shown on the left side of the figure. The tri-color cartridge includes the CMY colors. Even though these are both HP inks, they are for different printers and have a completely different shape and size.

NOTE **INK CARTRIDGE LOCATION**

The location of the ink cartridge varies from one printer to another. In many printers, the cartridges are close to the print head or even include the print head. In others, the cartridges are located farther away. Either way, ink cartridges are easy to replace.

The ink for inkjet printers often represents the highest cost for inkjet printers. In some cases, you can get a free printer with the purchase of a computer. Printer manufacturers realize that if you have the printer, you'll buy the ink, so they're willing to lose some money on the initial sale.

Refilling Inkjet Cartridges

Due to the cost of the ink, many people look for alternatives. You can buy do-it-yourself refill kits, but in general, these are not recommended. Most ink cartridges are vacuum-sealed, and it's difficult to replace the ink and keep the seal. Without the vacuum seal, the cartridge can leak and damage the printer.

> ***NOTE*** **REFILLING DOESN'T VOID WARRANTY**
>
> **By law, manufacturers can't void the warranty simply because you're not purchasing new ink from them. However, if the cartridge is filled incorrectly, it can damage the printer, and you're unlikely to get it fixed under warranty. Similarly, when you buy a car, you can change the oil yourself. However, if you don't secure the oil filter and the oil leaks out, don't expect the car company to cover the engine damage under the car's warranty.**

Another option is to have a professional service refill your cartridges. These services use high-quality ink and have the equipment necessary to keep a vacuum seal. For example, I was recently at a Costco store and learned that they do this in the photo department for many cartridges. You can bring in empty cartridges, and they'll refill them within an hour at a significantly lower cost than new ones.

Inkjet Printing Process

Inkjet printers work by ejecting ink onto the paper through microscopic nozzles in the print head. There are two primary methods used in the printing process: thermal (or bubble) and piezoelectric.

> ***NOTE*** **PAPER AND OTHER MEDIA**
>
> **General purpose paper will work for inkjet printers, laser printers, and copiers. However, if you want to get a higher-quality color printout, especially when printing photographs, you need to use paper created specifically for inkjet printers. A cool feature of inkjet printers is that they can print to a wide source of media. For example, you can buy transfer paper that allows you to print a photo and transfer it to something else, like a coffee mug or clothing.**

Thermal (or Bubble Jet) Printing

The print head in thermal or bubble jet printing uses small heaters to heat up the ink. As the ink heats, it creates a small bubble that is then ejected onto the paper.

Figure 7-13 shows the front of a print head for an inkjet printer. It has hundreds of microscopic nozzles, and each of these nozzles has the ability to eject ink bubbles onto the paper.

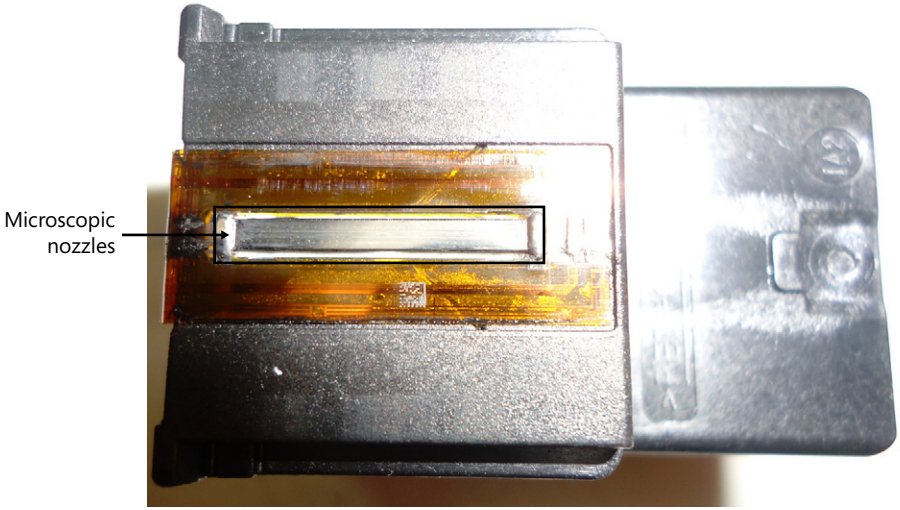


FIGURE 7-13 Inkjet printer print head.

This process was first discovered by Canon. Canon creates Bubble Jet printers. Many other manufacturers use a similar process, but they are generically referred to as thermal inkjet printers.

> ***NOTE*** **THERMAL INKJET PRINTERS VS. THERMAL PRINTERS**
>
> **Thermal inkjet printers are not the same as thermal printers. Thermal printers (discussed later in this chapter) use a special type of paper, and the print head heats the paper.**

Piezoelectric Printing

The *piezoelectric printing* process uses a crystal that vibrates when a voltage is applied. The printer sends a stream of ink to the print head and applies voltage to the crystal. The vibrations of the crystal cause the ink to break up into thousands of minute droplets. These droplets are given an electric charge as they form. Based on the charge, the droplets either stick to the paper or drop into a reservoir. Ink droplets sent to the reservoir are recycled.

There is a significant difference between thermal printing and piezoelectric printing. In a thermal inkjet printer, ink is sent through the head only when it's needed. In a piezoelectric inkjet printer, ink is sent through the head in a continuous stream whenever the printer is printing. The result is that the piezoelectric print heads rarely clog up. In contrast, the thermal inkjet print heads will often clog up, especially if they aren't used for a while.

Inkjet Print Heads

Inkjet print heads can be either fixed or disposable.

- **Fixed.** These are intended to last the lifetime of the printer. The cost to replace these is high compared with the cost of the printer. If they fail, you usually replace the printer.
- **Disposable.** Some disposable print heads are built into the ink cartridge. When you replace the ink, you're also replacing the print head. Other disposable print heads are separate from the ink, but they are usually very easy to replace.

A primary problem with inkjet print heads is that they can become clogged with dried ink. Manufacturers know this and include software tools you can use to clean them. It sends ink through the print head to clean it, so each time you clean it, you are using ink. Some printers have automatic cleaning cycles and will clean themselves periodically.

Inkjet Calibration

Inkjet print heads can develop minor alignment issues over time, resulting in a blurry output or lines that aren't straight. Printer manufacturers are aware of this and commonly include software tools you can use to check your printer and recalibrate if necessary.

For example, I have an inkjet printer that includes a print quality diagnostic tool. It prints out a page of different test patterns, including directions about what to look for and what actions to take.

- If lines aren't straight on one test pattern, the diagnostic tool recommends aligning the print heads by clicking a button.
- If it prints out thin white lines in another test pattern, it recommends cleaning the print heads by clicking a button.

Inkjet Printer Maintenance

Inkjet printers don't require a lot of maintenance. The primary issues are related to the paper path, the ink, and the print heads.

- **Paper path.** Paper jams sometimes just happen, but if they're happening often, the two things to check are the rollers and the paper. You can clean the rollers with isopropyl alcohol and a lint-free cloth or cotton swab. Ensure that you're using the right paper and that it isn't exposed to high humidity. You can clean the path with compressed air or an ESD-safe vacuum.
- **Ink.** When the ink runs out, you need to replace the cartridge. These are vacuum-sealed cartridges so it's very rare to see ink leak. Most printers include software tools you can use to check the current levels of the ink.
- **Print heads.** The print heads can become clogged with dried ink or can become misaligned with each other. Use the software tools to clean the heads or align the heads. Disposable heads can be replaced, and software will usually indicate when the heads are at the end of their lifetime.

NOTE **PAPER PATH**

Take your time when clearing a paper path. It's much easier to remove a whole sheet of paper, but if you rip it, it can be extremely difficult to get all the pieces out.

Quick Check

1. **What is the most expensive element of an inkjet printer?**
2. **What should be done if an inkjet printer includes misaligned colors?**

Quick Check Answers

1. **Ink.**
2. **Calibrate it.**

Impact Printers

Impact printers are one of the first types of printers used with computers. Even though the technology for impact printers is very old, they are still used in businesses where multipart forms are printed. I was recently at a car dealership, and they were using impact printers for contracts and other forms. Other places where you might see them include finance departments or billing services companies.

NOTE **Multipart forms**

A multi-part form has multiple sheets of paper separated with carbon paper. The impact of the print head also prints the other copies with the carbon paper. In contrast, other types of printers will print only the top sheet of paper in the multipart form.

The primary components of an impact printer are the platen, the ink ribbon, and the print head, shown as items 1, 2, and 3 in Figure 7-14. Impact printers commonly use a tractor feed and use continuous-feed paper. The paper has holes on the edges (item 4) that fit into sprockets in a tractor feed mechanism in the printer. The tractor feeder moves a continuous fan-fold roll of paper through the printer.

The platen is a hard, rubber-like material that provides a back for the print head. The ink ribbon is a long strip of cloth saturated with ink. It's connected to two rollers that steadily wind the ribbon from one roller to the other, and when it reaches the end, it switches directions. The print head has little hammer-like pins that hit the ribbon and press the ink from the ribbon onto the paper. A motor-and-carriage assembly moves the print head from side to side as it prints. When the printer finishes a line, the tractor feed advances the paper to the next line.

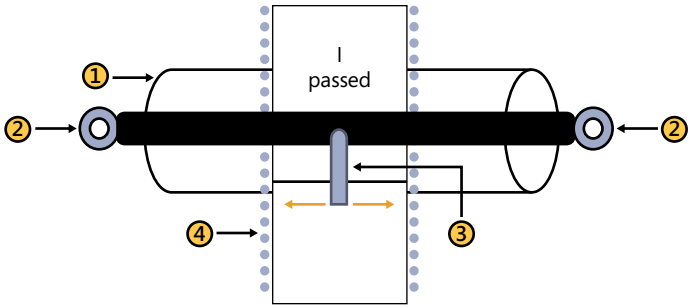


FIGURE 7-14 Elements of an impact printer.

Continuous-feed paper is perforated on the sides and between each individual sheet. After printing, you can tear it off the printer and remove the sides.

Some impact printers use regular sheets of paper instead of tractor-fed paper. The paper is moved through the printer with friction instead of with the tractor.

It's also worth pointing out that an impact printer can be very noisy. The pins have to strike the ribbon with force, and with more pins, it's more noise. In contrast, other printers are very quiet.

Creating Characters with a Dot Matrix

An impact printer print head includes multiple wires or pins that punch the ink ribbon onto the paper, leaving little dots. All the possible dots in a certain area represent a dot matrix, and dots within the matrix are printed to create characters or graphics.

Figure 7-15 shows how characters can be created with a simple 9-pin print head. The first part of Figure 7-15 represents the 9 pins in the print head. Each of these pins can be hammered onto the ink ribbon to create a dot. The middle part of the figure shows a sample dot matrix composed of six vertical lines of nine dots. The figure shows what you'd see if the 9-pin print head printed all nine dots in a 6 × 9 dot matrix.

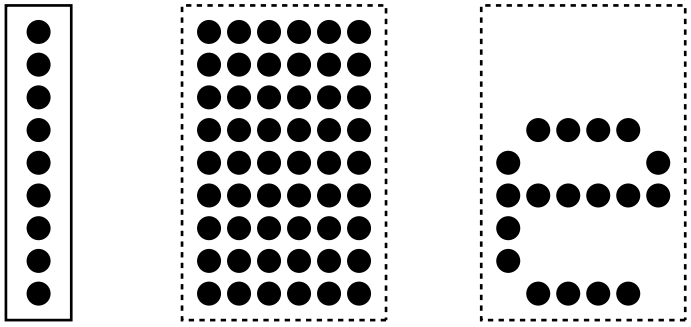


FIGURE 7-15 Forming a letter *e* with a dot matrix printer.

In the last part of the figure, you can see how the printer forms the letter *e* by selectively printing certain dots. Similarly, it can form any character or even simple graphics by printing dots.

Near-Letter Quality

Print heads with only 9 pins produce very basic outputs. For example, the letter *e* in Figure 7-15 clearly has many gaps between the dots. Today, most print heads include 24 pins or 48 pins and can produce near-letter quality (NLQ) output. The extra pins fill in the gaps between the dots.

The resolution from an NLQ printer is much better than what you'd see from a basic 9-pin print head. However, it isn't comparable at all to the resolution you can get from inkjet or laser printers.

Impact Printer Maintenance

Impact printers are relatively easy to work with, and you don't have many problems. The primary maintenance issues include the following:

- **Paper dust.** It's very common for these printers to build up a lot of paper dust within them, especially with tractor feed paper. You should clean them out regularly with compressed air or an ESD-safe vacuum cleaner.
- **Paper path.** As with other printers, the paper path can get jammed. You can normally see the entire path of an impact printer, so it's usually fairly easy to clear a paper jam.
- **Ink ribbon.** As the ink ribbon is used, the ink runs out and the printout fades. The solution is easy: replace the ribbon.
- **Print head.** The pins on the print head can jam so that they no longer fire. The most common cause is paper dust, so when you clean out the printer, you should also clean the print head. Compressed air works well. When a pin stops firing in a print head, the only option is to replace the head.
- **Platen.** The platen can develop dents over time, but you can often rejuvenate it by rubbing it with isopropyl alcohol.

Thermal Printers

Thermal printers are used to print cash register receipts, ATM transaction slips, and even lottery tickets. Older fax machines used thermal printers too, but most fax machines now capture the incoming fax as a file that can be printed with a laser or inkjet printer.

Thermal printers use a special type of thermal paper that is covered with a chemical. When the chemical is heated, it changes color. Most thermal printers can print only a single color, but some can print two colors. The paper is normally on a roll with a center sprocket, and cashiers can usually replace an empty roll in less than a minute.

Other components of a thermal printer are as follows:

- A feed assembly that feeds the thermal paper through the printer. The feed assembly uses the sprocket in the center of the roll to advance the paper.
- A print head that includes a heating element to heat the paper.

Thermal printers are relatively slow, with their speed measured in inches per second (ips). However, they don't need to print much.

As with most printers, thermal printers need to be cleaned periodically with compressed air or an ESD-safe vacuum to remove debris. You can clean the print head with isopropyl alcohol and a lint-free cloth or a cotton swab. Cleaning the print head extends its life, but you can replace it if it fails.

EXAM TIP

Know where each type of printer is most commonly used. Laser printers are used in larger organizations. Inkjet printers are used by home users and SOHOs. Impact printers are used in businesses that need multipart forms. Thermal printers are used for receipts.

Quick Check

1. **Which type of paper does an impact printer typically use?**
2. **What do thermal printers commonly print?**

Quick Check Answers

1. **Tractor-fed continuous paper.**
2. **Receipts and lottery tickets.**

Installing and Configuring Printers

Printers must be installed before you can use them, but this is usually very easy. The majority of printers use a USB interface, and Windows will configure the printer automatically as soon as you plug it in. However, you should know about some other possibilities when installing and configuring printers.

Device Drivers

When printer manufacturers create printers, they also write device drivers for different operating systems. These drivers provide the operating system with the details it needs to communicate with the device. When you buy a new printer, the manufacturer includes a CD with software that you can use to install it.

MORE INFO **CHAPTER 5, "EXPLORING PERIPHERALS AND EXPANSION CARDS"**

Chapter 5 discusses drivers related to any peripherals and how it is sometimes necessary to install the driver before connecting the device. If the instructions say you should install the driver first, you'll save yourself a lot of problems by doing so.

Most manufacturers also submit drivers to Microsoft. If the drivers meet certain quality assurance requirements, Microsoft makes them available via Windows Update. Chapter 15, "Configuring Windows Operating Systems," covers drivers and Windows Update in more depth, but you can also watch a short video that goes through the process here: *http://windows.microsoft.com/en-us/windows7/Find-and-install-printer-drivers*.

If none of these methods work, you can go to the manufacturer's website to locate the correct driver. If you can't find a suitable driver, the printer will typically produce a garbled output.

NOTE **DRIVER AVAILABILITY**

When a new operating system comes out, it often takes time before drivers are written and made publicly available. For example, when Windows Vista first came out, many printers had drivers for Windows XP but not for Windows Vista. The good news is that any printer driver that works for Windows Vista will for Windows 7.

Required Permissions

On Windows Vista and Windows 7, regular users can install the printer without any special permissions as long as the print driver is available. If the print driver isn't available, the user will need administrative permission to install a different print driver. Also, administrative permissions are required to install applications, so regular users will not be able to install software applications that come with a printer.

On Windows XP, users need to be in the Power Users group to install a printer or add a different driver.

MORE INFO **CHAPTER 25, "UNDERSTANDING IT SECURITY"**

The Power Users group is included in Windows Vista and Windows 7 for backward compatibility only. Chapter 25 discusses groups in more depth.

Wired Connections

The most common way a printer is connected is by using a USB connection. Printers commonly have a USB Type B port, and you use a cable with a USB Type A connector on one end for the computer and a USB Type B connector on the other end for the printer.

Before USB became so popular, printers were connected to a printer via the parallel DB-25 port mentioned in Chapter 5. While rare, it was also possible to connect some printers to the serial DB-9 port. USB is much faster than either parallel or serial, so you're unlikely to see these connections unless you're working with an old printer.

Another option is connecting a printer to a network by using Ethernet. Chapters 18 through 24 cover networking in much more detail, but for a quick preview, take a look at Figure 7-16. You can see two networked printers on the left and one locally connected printer on the right. One is connected to a server that functions as a print server, and the other is connected directly into the network through a switch. The first printer can be connected to the server with a USB connection, and the second printer will typically be connected with a twisted-pair cable and an RJ-45 connection.

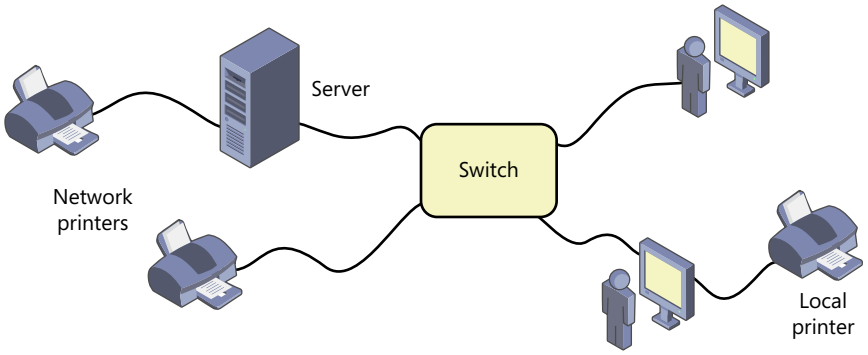


FIGURE 7-16 Wired printer connections.

NOTE **LOCAL PRINTER**

When you connect a printer directly to a computer, it's referred to as a *local printer*. When a printer is accessed over a network, it's called a *networked printer*.

The benefit of having printers on the network is that multiple users can access them. When they are connected with a print server, the server manages the print jobs and can also store and distribute printer drivers. The print server makes it easier to manage the printers but has additional costs for the server.

When printers are connected directly to the network, they have more management requirements. For example, you typically need to manually assign a specific Internet Protocol (IP) address to the printer or configure Dynamic Host Configuration Protocol (DHCP) to reserve a specific IP address for it. Don't worry if this sounds unfamiliar right now; networking will become clearer later in this book.

Wireless Connections

Many printers include wireless capabilities that allow wireless systems to connect to them without a wired connection. The common types of wireless connections include the following:

- **802.11.** Wireless networks use one of the 802.11 protocols, such as 802.11a, 802.11b, 802.11g, or 802.11n. Chapter 23, "Exploring Wireless Networking," covers wireless technologies in more detail.
- **Bluetooth.** Bluetooth is commonly used to create personal area networks (PANs), such as with a mobile phone and a headset. Some printers support Bluetooth, and with Class 2 Bluetooth, the printer can be as far as 10 meters (33 feet) away.
- **Infrared.** Television remotes use infrared, and it has been used with printers. A drawback is that it requires a clear line of sight between the printer and the computer.

MORE INFO **CHAPTER 9 AND CHAPTER 23**

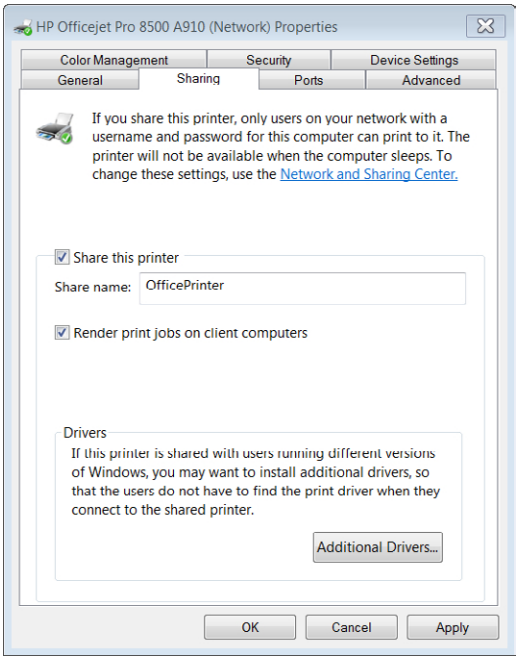
Chapter 9, "Understanding Mobile Devices," mentions both Bluetooth and Infrared. The 802.11 protocols are covered in more depth in Chapter 23.

Printer Sharing

In addition to sharing printers by placing them on the network, you can also share local printers. If you share a printer on a networked computer, other users on the network will be able to send their print jobs through this computer. For example, if you have a wireless network, you can connect a local printer to one computer and share it. Other users on the network can then print to the printer.

The following steps show how to share a printer on Windows 7:

1. Click Start and select Devices And Printers.
2. Locate the printer in the Printers And Faxes section. Right-click the printer and select Printer Properties.
3. Click the Sharing tab.
4. Select the Share This Printer check box, as shown in the following graphic.



5. If desired, you can change the share name. Click OK.

> ***NOTE*** **RENDERING PRINT JOBS**
>
> **It's best to select Render Print Jobs On Client Computers, as shown in the graphic. The computer that is sending the print job will use its processing power to format the print job.**

At this point, users can use the Universal Naming Convention (UNC) to connect and install the printer. The format is *computerName**shareName*. For example, if the computer is named Win7 and the printer is named OfficePrinter, users can connect by using \\Win7\OfficePrinter.

Adding a Network Printer

USB printers are automatically installed when you plug them in. However, you have to take some additional steps to add a networked printer to a computer. You can use the following steps to add a networked printer on a Windows 7–based computer.

1. Click Start and select Devices And Printers.
2. Click Add A Printer.
3. Click Add A Network, Wireless Or Bluetooth Printer.
4. Windows 7 will search the network looking for the printer. When you see the printer, select it and click Next.

5. Windows will attempt to automatically locate the driver. If it can't locate it, you'll be prompted to select it by first selecting the manufacturer and then selecting the printer model.
6. Select the printer, click Next, and then click Finish.

Print Management

Print Management is available in Windows Vista and Windows 7 (and in Windows Server products), and you can use it to manage multiple shared printers. It's not common to manage multiple printers on a desktop system such as Windows 7, so you're unlikely to use Print Management on these systems. However, it is useful on print servers.

One big benefit is that you can update the drivers for printers in the Print Management console. When a system connects to the computer sharing the printer, it automatically receives the updated driver.

You can access the Print Management Console on Windows 7 by clicking Start, typing **Print Management** in the Search Programs And Files text box, and pressing Enter. Alternatively, you can access it via the Control Panel by clicking Systems And Security, Administrative Tools, and Print Management.

Printer Webpages

Many network-compatible printers include software that allows them to serve webpages. If you know the IP address of the printer, you can type it into a web browser to access these pages. If you don't know the IP address, print a local test page. It's usually included on the printout. Figure 7-17 shows a sample webpage.

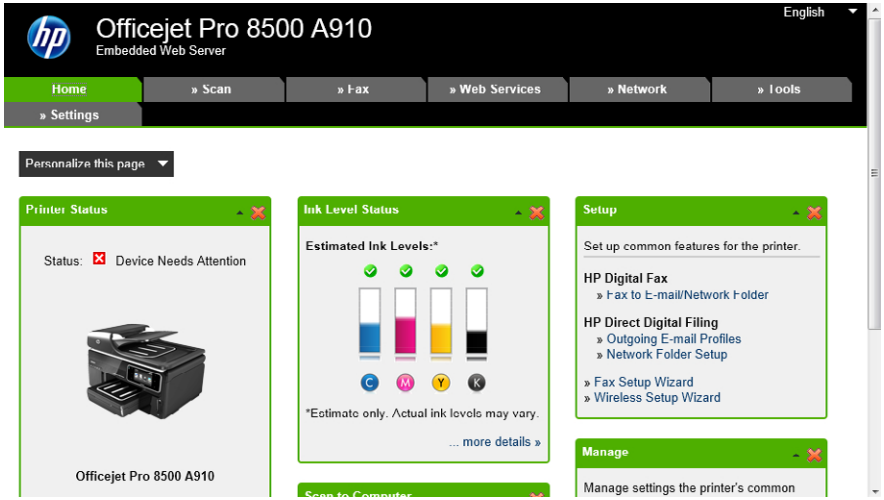


FIGURE 7-17 Printer webpage.

In Figure 7-17, you can see that the printer has a problem and needs attention. This printer includes multiple tools that can be used to troubleshoot and resolve the problem. These tools are available on the Tools tab for this printer. It also includes settings that can be configured for the printer.

Print Spooler

When you send a print job to a printer, it isn't sent to the printer right away. Instead, your computer sends the print job to a file called a spooler. The printer has a limited amount of memory and can print only so fast, so the spooler coordinates with the printer to get the print job to it in chunks.

You can think of the print job as a thread that is collected and wound onto a spool when you print it, and it's unwound when it's sent to the printer. After the spooler captures the print job, you can go on to other things. It works in the background to spool the print job out to the printer.

If you send multiple print jobs to a printer, the print spooler will queue each of these jobs. When one print job finishes, it starts sending the next print job.

The print spooler runs as a service, and services start up automatically when the computer starts. In contrast, applications such as Internet Explorer start only when a user starts them. Therefore, you don't need to start the print spooler service. However, you might need to *restart* it.

A common problem with the print spooler is that it can occasionally lock up and stop sending print jobs to the printer. If you try to print more print jobs, they just back up in the queue. The solution is to restart the print spooler service.

EXAM TIP

If print jobs back up in the queue, restart the spooler service. Each computer includes a printer spooler and a print queue so that it is possible for one user to print without any problems while the print queue on another computer is backed up.

Chapter 13, "Using Windows Operating Systems," covers the Services applet in more detail, but in brief, you can use it to manipulate any services. You can stop, start, pause, resume, or restart a service. You can also disable a service or configure how it will start.

Quick Check

1. **How are printers commonly connected to a PC?**
2. **What is the print spooler?**

Quick Check Answers

1. USB.
2. A Windows service that accepts print jobs and sends them to the printer.

Troubleshooting Printers

If you understand the basics about how different printers operate, you can often identify printer problems and resolve them without too much difficulty. Still, it's good to have a little cheat sheet listing common symptoms, causes, and solutions, similar to the following:

- **Printer will not print.** Check the basics. Ensure that it is plugged in, turned on, and properly connected. Some printers have an online/offline selection, and when it is offline, Windows treats it as though it is turned off. Setting it back to online allows everything to work normally.
- **No connectivity—local printer.** The computer might give an error indicating the printer can't be contacted. Ensure that the data cables are connected. Sometimes reseating the cables by disconnecting and reconnecting them will resolve the problem.
- **No connectivity—network printer.** If all users are having the same problem, ensure that the printer is on, connected, and configured. If only one user is having the problem, ensure that the user is sending the print job to the correct printer. You might need to reinstall the printer for that user's computer.

EXAM TIP

A common problem with a network printer occurs if it is getting an IP address from DHCP instead of having a static IP address. When it is turned off and back on, it will receive a different IP address and users won't be able to connect to it anymore. Refer to Chapter 21, "Comparing IPv4 and IPv6," for a discussion about assigning a static IP address or reserving a specific IP address.

- **Paper not feeding.** Check the rollers or tractor feed to ensure that they are working. In some cases, rollers can become dirty and work inconsistently. Cleaning them resolves the problem.
- **Creased paper.** Printers often crease the paper as it is fed through the paper path, but it should not be noticeable unless you're using a heavier bond paper. A solution is to send the paper through the feeder rather than through the paper tray.
- **Paper jam.** The first solution is to clear the jam, but you should also check the paper path to ensure that it is free of debris. Repeating paper jams can be due to using low-quality paper or paper that has been exposed to high humidity. It's also possible that the pickup and separator rollers are worn and more than one sheet of paper is being

picked up. Some printers report a paper jam when the rollers are unable to pick up the paper. Replacing the rollers with a maintenance kit might resolve the problem.

- **Garbled characters on paper.** The most likely reason for this is using the wrong print driver. Double-check to ensure that the correct driver is installed, and if necessary, update the driver. This might also be due to a cable issue. For example, the maximum distance of a USB 2.0 cable is 5 meters (about 16 feet), and using a longer cable can result in a garbled output. Reseating the cable will ensure that you don't have a loose connection.

EXAM TIP

Exam questions may refer to a specific brand or model of a printer. Don't let this distract you. The exam is vendor-neutral, and the question is typically asking a generic question that could be applied to any printer of the same type.

- **Backed-up print queue.** If the printer or the print spooler service has been paused, print jobs won't print. Instead, they stay in the queue. Resume the print spooler service. In some cases, the print spooler service just locks up, and the only way to resolve the problem is to restart it.
- **Access denied.** By default, the Everyone group is assigned Allow Print permission so that anyone can print. However, administrators can modify this. If you're seeing this error, it indicates that the user isn't authorized to use the printer.
- **Unable to install printer.** In Windows XP, a user needs to be in the Power Users or Administrators group to install a printer, and if not, they will be unable to install a printer. Regular users can install printers on Windows 7.
- **Blank pages.** If you see this on a laser printer, it could indicate that the toner is empty, although users would normally complain as the toner gets low. You can also see this after replacing a toner cartridge without removing the sealing tape. Last, it's possible that the charging process isn't occurring due to a problem with the high-voltage power supply, the primary charge roller, or the corona wire.
- **Faded print.** This indicates that you're low on toner or ink. Replacing the toner, ink cartridge, or ink ribbon should eliminate this problem. On impact printers, this problem occurs if the ink ribbon stops moving.
- **Streaks on a laser printer.** Streaks on a laser printer are most likely the result of scratches on the imaging drum, especially if they are occurring in the same location on the printed page. The only solution is to replace the drum.
- **Streaks on an inkjet printer.** On inkjet printers, this can be caused by dirty or misaligned print heads. Use the software tools to clean and align them.
- **Ghost images due to image problem.** Ghosting can occur on laser printers after printing a dark image. Try printing a blank page between images. Also, you can reduce the resolution or darkness of the first page to eliminate the problem.

- **Ghost images due to hardware problem.** If the drum isn't adequately cleaned or adequately charged, it can cause ghosting. You might need to replace the cleaning scraper or the primary charge roller.

EXAM TIP

The toner cartridge includes many other components on different printers. You can often resolve a wide variety of problems simply by replacing the toner cartridge.

- **Vertical lines on page.** You can see this on laser printers if the toner gets clogged. The solution is to remove the cartridge and shake it or to replace the cartridge. It can also occur if the drum is scratched or dirty. On inkjet printers, this can occur if the print heads are dirty or misaligned. Clean and align them.
- **Color prints in wrong print color.** If the ink cartridges or color toner cartridges are inserted in the wrong location, you'll see some psychedelic results. The solution is to put them into the correct locations, but it might take time for the colors to return to normal. Some inkjet printers recycle the ink, so you'll still have a mixture of the wrong ink.
- **Low memory errors.** When the RIP creates the raster image, it stores it in memory. If the image is larger than the available memory, you'll receive a memory error. The best solution is to add memory to the printer if it supports additional memory. An alternative is to simplify the image by using a lower resolution or fewer graphics.
- **Error codes.** Many printers give error codes. They can be cryptic numbers you need to look up in a printer manual, or they can be plain words, such as "Out of paper." Many inkjet printers have a color LCD panel that displays the error, and if you touch it for information, it shows graphics demonstrating how to resolve the problem.
- **Toner not fused to the paper.** The fuser assembly fuses the toner to the paper. Replace the fuser to resolve the problem.

Quick Check

1. **What is the most likely cause of a garbled output?**
2. **What should be done to resolve a backed-up print queue problem?**

Quick Check Answers

1. **Incorrect driver.**
2. **Restart the print spooler service.**

Chapter Summary

- Duplexing assemblies are required to print two sides.
- Common maintenance tools used with printers include compressed air, ESD-safe vacuum cleaners (with HEPA filters for laser printers), isopropyl alcohol, and lint-free cloths or cotton swabs.
- Common printers are laser, inkjet, impact, and thermal.
  - Laser printers are fast and provide a high-quality output. They are more expensive than other printers and are commonly used in larger organizations.
  - Inkjet printers are inexpensive and provide high-quality color output but are slower than laser printers. They are very popular among home users and small businesses. Ink is very expensive.
  - Impact printers are slow, noisy, and generate a lot of paper dust. They are used most often by businesses that need to print multipart forms.
  - Thermal printers are special-purpose printers used to create receipts or print lottery tickets.
- Laser printers use the following seven-step imaging process: processing, charging, exposing, developing, transferring, fusing, and cleaning.
- The RIP processes the image and stores it in memory during the processing stage. Complex images require more memory.
- A high-voltage charge is applied to the drum from a primary charge roller during the charging stage. A laser then writes the image onto the drum during the exposing stage.
- Toner is a fine powder of carbon and plastic. It is charged during the developing stage and applied to the drum.
- A transfer roller electrically charges paper, and the image is transferred to the paper during the transferring stage.
- Toner is melted onto the paper by a fusing assembly in the fusing stage. The drum is then cleaned to prepare for the next image in the cleaning stage.
- Laser printers include dangerously high voltages and hot components. They should be unplugged prior to servicing.
- You typically apply a maintenance kit when replacing the toner, which often includes a replacement ozone filter.
- Inkjet printers have print heads with microscopic holes that inject ink onto the paper. They can create high-quality color output and are very popular with home users.
- Inkjet print heads can become clogged or misaligned. Cleaning or aligning them will resolve most problems.

- Impact printers hammer pins against an ink ribbon to print dots on paper. They are used to print multipart forms.
- Thermal printers use a special thermal paper that changes color when heated by the print head.
- USB printers will install automatically without any user intervention. Network printers must be installed.
- The print spooler service coordinates sending print jobs to a printer. If the print queue backs up, restart it.
- Many printer problems have clear symptoms, causes, and solutions. You'll often find that taking steps to clean a printer resolves many problems. Additionally, replacing a toner cartridge on a laser printer resolves many problems.

Chapter Review

Use the following questions to test your knowledge of the information in this chapter. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. What is a duplexing assembly used for in a printer?
   - **A.** To print on both sides of the paper
   - **B.** To improve RAID-1
   - **C.** To allow two-way communication
   - **D.** To double the speed of the printer
2. A customer wants to buy a printer for home use that can print color. She asks you for your advice. What would you recommend?
   - **A.** Dot matrix printer
   - **B.** Color laser printer
   - **C.** Inkjet printer
   - **D.** Laser printer
3. You are preparing to replace a toner cartridge on a laser printer. Which of the following steps should you take first?
   - **A.** Restart the print spooler.
   - **B.** Turn off the printer.
   - **C.** Remove the new toner from the package.
   - **D.** Print a test page.

4. Of the following choices, what is *not* used to connect a wired printer?

   A. USB

   B. Parallel

   C. 802.11

   D. Ethernet

5. What should you do if an inkjet printer is printing random streaks?

   A. Replace the toner cartridge.

   B. Clean the fusing assembly.

   C. Update the drivers.

   D. Clean the print heads.

6. You are troubleshooting a problem with an HP6L laser printer. One LED is steady red, and another is blinking orange. The customer complains that it prints streaks in the same place on every page. What is the most likely problem?

   A. The imaging drum

   B. The fuser

   C. An incorrect print driver

   D. Impossible to tell without the manual

Answers

1. **Correct Answer:** A
   - **A. Correct:** Duplexing assemblies can automatically flip paper in a printer to print both sides.
   - **B. Incorrect:** Duplexing improves RAID-1 by adding a second disk controller, but this is not related to printers.
   - **C. Incorrect:** In networking, duplex indicates a device has two-way communication, but that is unrelated to printers.
   - **D. Incorrect:** They do not increase the speed.
2. **Correct Answer:** C
   - **A. Incorrect:** A dot matrix printer would be appropriate if she wanted to print multipart forms.
   - **B. Incorrect:** A color laser printer is much more expensive than an inkjet printer.
   - **C. Correct:** Inkjet printers print color and are very popular for home users.
   - **D. Incorrect:** Regular laser printers do not print color.
3. **Correct Answer:** B
   - **A. Incorrect:** Restart the spooler if the queue is backed up.
   - **B. Correct:** You should turn off the printer as a safety precaution before servicing a laser printer.
   - **C. Incorrect:** You should unpack the new toner only when you're ready to install it.
   - **D. Incorrect:** You could print a test page as a final step to confirm proper operation of the printer.
4. **Correct Answer:** A
   - **A. Incorrect:** USB is the most common method.
   - **B. Incorrect:** Parallel is not a common method, but it has been used to connect a wired printer.
   - **C. Correct:** 802.11 refers to wireless technologies.
   - **D. Incorrect:** Ethernet is used to connect printers over a wired network.
5. **Correct Answer:** D
   - **A. Incorrect:** Inkjet printers do not have toner cartridges.
   - **B. Incorrect:** Inkjet printers do not have fusing assemblies.
   - **C. Incorrect:** A driver would not cause random streaks.
   - **D. Correct:** Cleaning and aligning the print heads will likely resolve this problem.

6. **Correct Answer:** A

   A. **Correct:** Streaks are very likely caused by scratches on the imaging drum for any type of laser printer.

   B. **Incorrect:** If toner wasn't sticking to the paper, the fuser is the likely problem.

   C. **Incorrect:** The wrong driver results in garbled output.

   D. **Incorrect:** The manual will help you interpret the lights, but the streaks indicate a scratched drum.