Ozone Filter
Your laser printer uses various high-voltage biases inside the case. As anyone who has been outside during a lightning storm can tell you, high voltages create ozone. Ozone is a chemically reactive gas that is created by the high-voltage coronas (charging and transfer) inside the printer. Because ozone is chemically reactive and can severely reduce the life of laser printer components, many older laser printers contain a filter to remove ozone gas from inside the printer as it is produced. This filter must be removed and cleaned with compressed air periodically (cleaning it whenever the toner cartridge is replaced is usually sufficient). Most newer laser printers don’t have ozone filters. This is because these printers don’t use transfer corona wires but instead use transfer corona rollers, which dramatically reduce ozone emissions.

Duplexing Assembly
Any laser printer worth its money today can print on both sides of the paper. This is accomplished through the use of a duplexing assembly. Usually located inside or on the back of the printer, the assembly is responsible for taking the paper, turning it over, and feeding back into the printer so the second side can be printed.

Electrophotographic (EP) Print Process
The EP print process is the process by which an EP laser printer forms images on paper. It consists of seven major steps, each for a specific goal. Although many different manufacturers call these steps different things or place them in a different order, the basic process is still the same. Here are the steps in the order you will see them on the exam:

1. Processing
2. Charging
3. Exposing (writing)
4. Developing
5. Transferring
6. Fusing
7. Cleaning

Before any of these steps can begin, however, the controller must sense that the printer is ready to start printing (toner cartridge installed, fuser warmed to temperature, and all covers in place). Printing cannot take place until the printer is in its ready state, usually indicated by an illuminated Ready LED light or a display that says something like 00 READY (on HP printers). The computer sends the print job to the printer, which begins processing the data as the first step to creating output.

Step 1: Processing
If you think back to our discussion of dot-matrix printing earlier in this chapter, you might recall that dot-matrix printers produce images by creating one strip of dots at a time across
the page. Laser printers use the same concept of rendering one horizontal strip at a time to create the image. Each strip across the page is called a scan line or a raster line.

A component of the laser printer called the Raster Image Processor (RIP) manages raster creation. Its responsibility is to generate an image of the final page in memory. How the raster gets created is dependent upon the page description language that your system is using, such as PostScript (PS) or Printer Control Language (PCL). Ultimately, this collection of lines is what gets written to the photosensitive drum and on to the paper.

**Step 2: Charging**

The next step in the EP process is the charging step (Figure 10.15). In this step, a special wire or roller (called a charging corona) within the EP toner cartridge (above the photosensitive drum) gets a high voltage from the HVPS. It uses this high voltage to apply a strong, uniform negative charge (around $-600\text{V}_{\text{DC}}$) to the surface of the photosensitive drum.

**FIGURE 10.15** The charging step of the EP process

![Charge corona wire](image)

**Step 3: Exposing (writing)**

Next is exposing the drum to the image, often referred to as the writing step. In this step, the laser is turned on and scans the drum from side to side, flashing on and off according to the bits of information the printer controller sends it as it communicates the individual bits of the image. Wherever the laser beam touches, the photosensitive drum’s charge is severely reduced from $-600\text{V}_{\text{DC}}$ to a slight negative charge (around $-100\text{V}_{\text{DC}}$). As the drum rotates, a pattern of exposed areas is formed, representing the image to be printed. Figure 10.16 shows this process.

At this point, the controller sends a signal to the pickup roller to feed a piece of paper into the printer, where it stops at the registration rollers.

**Step 4: Developing**

Now that the surface of the drum holds an electrical representation of the image being printed, its discrete electrical charges need to be converted into something that can be transferred to a piece of paper. The EP process step that accomplishes this is the developing step (Figure 10.17). In this step, toner is transferred to the areas that were exposed in the writing step.
A metallic roller called the developing roller inside an EP cartridge acquires a \(-600\text{VDC}\) charge (called a bias voltage) from the HVPS. The toner sticks to this roller because there is a magnet located inside the roller and because of the electrostatic charges between the toner and the developing roller. While the developing roller rotates toward the photosensitive drum, the toner acquires the charge of the roller \((-600\text{VDC})\). When the toner comes between the developing roller and the photosensitive drum, the toner is attracted to the areas that have been exposed by the laser (because these areas have a lesser charge, \(-100\text{VDC}\)). The toner also is repelled from the unexposed areas (because they are at the same \(-600\text{VDC}\) charge and like charges repel). This toner transfer creates a fog of toner between the EP drum and the developing roller.

The photosensitive drum now has toner stuck to it where the laser has written. The photosensitive drum continues to rotate until the developed image is ready to be transferred to paper in the next step.
**Step 5: Transferring**

At this point in the EP process, the developed image is rotating into position. The controller notifies the registration rollers that the paper should be fed through. The registration rollers move the paper underneath the photosensitive drum, and the process of transferring the image can begin; this is the **transferring step**.

The controller sends a signal to the charging corona wire or roller (depending on which one the printer has) and tells it to turn on. The corona wire/roller then acquires a strong positive charge (+600VDC) and applies that charge to the paper. The paper, thus charged, pulls the toner from the photosensitive drum at the line of contact between the roller and the paper because the paper and toner have opposite charges. Once the registration rollers move the paper past the corona wire, the static-eliminator strip removes all charge from that line of the paper. Figure 10.18 details this step. If the strip didn't bleed this charge away, the paper would attract itself to the toner cartridge and cause a paper jam.

The toner is now held in place by weak electrostatic charges and gravity. It will not stay there, however, unless it is made permanent, which is the reason for the fusing step.

**FIGURE 10.18** The transferring step of the EP process

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**Step 6: Fusing**

The last step before the printer produces the finished product is called the fusing step. Here the toner image is made permanent. The registration rollers push the paper toward the fuser rollers. Once the fuser grabs the paper, the registration rollers push for only a short time more. The fuser is now in control of moving the paper.

As the paper passes through the fuser, the 350°F fuser roller melts the polyester resin of the toner, and the rubberized pressure roller presses it permanently into the paper (Figure 10.19). The paper continues through the fuser and eventually exits the printer.

Once the paper completely exits the fuser, it trips a sensor that tells the printer to finish the EP process with the cleaning step.

**Summary of the EP Print Process**

Figure 10.21 summarizes all the parts involved in the EP printing process. First, the printer processes the image and stores a page in memory. Then the printer places a
uniform –600VDC charge on the photosensitive drum by means of a charging corona. The laser “paints” an image onto the photosensitive drum, discharging the image areas to a much lower voltage (–100VDC). The developing roller in the toner cartridge has charged (–600VDC) toner stuck to it. As it rolls the toner toward the photosensitive drum, the toner is attracted to (and sticks to) the areas of the photosensitive drum that the laser has discharged. The image is then transferred from the drum to the paper at its line of contact by means of the transfer corona wire (or corona roller) with a +600VDC charge. The static-eliminator strip removes the high, positive charge from the paper, and the paper, now holding the image, moves on. The paper then enters the fuser, where a fuser roller and the pressure roller make the image permanent. The paper exits the printer, and the printer uses a rubber scraper to clean the photosensitive drum. At that point, it is ready to print the next page or it returns to its ready state.

**FIGURE 10.19** The fusing step of the EP process

![Fusing roller and Pressure roller](image)

**Step 7: Cleaning**

In the final part of the laser print process, a rubber blade inside the EP cartridge scrapes any toner left on the drum into a used toner receptacle inside the EP cartridge, and a fluorescent lamp discharges any remaining charge on the photosensitive drum (remember that the drum, being photosensitive, loses its charge when exposed to light). This step is called the *cleaning step* (Figure 10.20).

**FIGURE 10.20** The cleaning step of the EP process

![Cleaning blade, Used toner hopper, Print drum](image)
The EP cartridge is constantly cleaning the drum. It may take more than one rotation of the photosensitive drum to make an image on the paper. The cleaning step keeps the drum fresh for each use. If you didn’t clean the drum, you would see ghosts of previous pages printed along with your image.

At this point, the printer can print another page, and the EP process can begin again.

**NOTE**

The amount of toner removed in the cleaning process is quite small. The cartridge will run out of toner before the used toner receptacle fills up.

**FIGURE 10.21** The EP print process

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**Thermal Printers**

The types of printers you have learned about so far in this chapter account for 90 percent of all printers that are used with home or office computers and that you will see as a repair technician. The other 10 percent consist of other types of printers that primarily differ by the method they use to put colored material on the paper to represent what is being printed. Examples of these include solid ink, dye sublimation, and thermal printers. Keep in mind that for the most part, these printers operate like other printers in many ways: They all have a paper-feed mechanism (sheet-fed or roll); they all require consumables such as ink or toner and paper; they all use the same interfaces, for the most part, as other types of printers; and they are usually about the same size.

Thermal printing technology is used in many Point of Sale terminals and older fax machines (newer fax machines usually use inkjet or laser technology). They print on a kind of special, waxy paper that comes on a roll; the paper turns black when heat passes over it. *Thermal printers* work by using a print head the width of the paper. When it needs to print, a heating element heats certain spots on the print head. The paper below the heated print head