

Laser Printer Guide

Technical Manual

Laser Printer Technology

Introduction:

Laser printers use a highly focused beam of light called a LASER (Light Amplification by Stimulated Emission of Radiation) and toner. Toner is the black carbon substance that's used to create images on paper or film. Laser printers provide the highest image quality and are fast when compared with dot matrix and inkjet printers. While laser printers are more expensive and relatively large, their ability to produce high capacity and high quality prints makes them popular printers in the workplace and in school classrooms.



Laser printers are sophisticated electromechanical devices. Although they're pretty reliable, they do require a bit of maintenance and sometimes need repair. Knowing how laser printers work will help you know how to service and repair them.

Words and Terms You Should Know:

- **Insulating Object** Builds up electrical charge, for example a balloon or you body
- **Photoreceptor** The core component of a laser printer, usually a revolving drum or cylinder
- **Drum Assembly** Holds the photoconductive material and a cleaning blade that scrapes the "used" toner off the drum, can hold a static charge when NOT exposed to light
- **Photoconductive** Material that is discharged by light photons, a surface that is sensitive or responsive to light
- **Charge Corona Wire** A wire with an electrical current running through it
- **Electrostatic Image** A pattern of electrical charges
- **Toner** A fine, black carbon substance, made up of pigment and plastic
- **Transfer Corona Wire** Gives the paper a negative charge, charged roller
- **Detac Corona Wire** Discharges the paper right after it picks up the toner, keeps paper from clinging to the drum
- **Fuser** A pair of heated rollers
- **Discharge Lamp** Bright light that exposes the entire photoreceptor surface, erasing the electrical image
- **Printer Controller** Laser printer's main onboard computer, receives the page data and figures out how everything will be put on the page, may have to stop the printer periodically to process the information that is being received
- **Print-Engine Computer** Synchronizes the image distortion caused by the varying distance between the mirror and the drum
- **Page Data** The tiny dots that make up the text and images
- **Page Description Language** Language both the printer controller and the host computer must "speak" in order to communicate with each other
- **Printer Command Language (PCL)** One of the primary printer languages, used by Hewlett Packard
- **Postscript** One of the primary printer languages, used in Adobe
- **Vector** Mathematical values of geometric shapes used to describe the page
- **Bitmap** Series of dots used to describe the page

- **Graphical Device Interface (GDI)** Format system, in which the host computer creates the dot collection itself
- **Raster Image Processor (RIP)** Takes the page data, and breaks it down into tiny dots, this is necessary for the laser to write out the page
- **Laser Scanning Assembly** Laser system including a laser, a movable mirror, and a lens used to draw the page
- **Light-Emitting Diodes (LEDs)** Used by some laser printers, instead of a laser, to write the page image
- **Toner Hopper** A small container built into a removable casing, holds the toner
- **Developer Unit** "Developer" is actually a collection of small, negatively charged magnetic beads, gathers the toner from the toner hopper
- **Internal Quartz Tube Lamps** Used to heat the fuser rollers, so the plastic in the toner melts as it passes through and thus binds to the paper
- **Teflon** Non-stick material, used to prevent the toner from collecting on the fuser
- **Monochrome Printing** Prints ONLY black writing on white paper, no color printing

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The Basic Printing Process

Believe it or not... Static electricity is the key to how a laser printer works. You know the rules of static electricity...

- Opposite Charges Attract
- Like Charges Repel
- All Charges Become Neutral Over Time

Like charging a balloon and sticking it to your body, static electricity is simply an electrical charge built up on an insulated object. Since oppositely charged particles are attracted to each other, objects with opposite static electricity fields cling together.

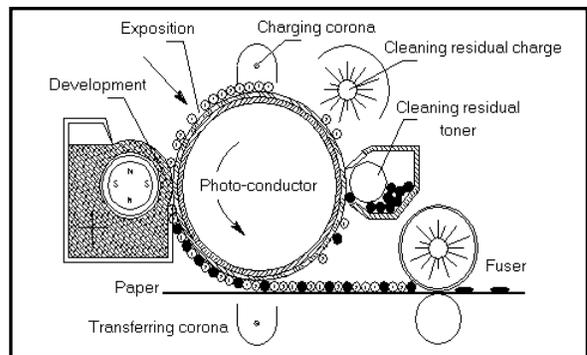


Figure 1 The basic components of a laser printer.

A laser printer uses static electricity as a sort of "temporary glue." The main component of this system is the photoreceptor, usually a revolving drum or cylinder. This drum assembly is made out of highly photoconductive material that is discharged by photons of light.

Figure 1 shows a typical imprinting system used in laser printers. Here's how it works... Initially, the drum is given a total positive charge by the charge corona wire, a wire with an electrical current running through it. (Some printers use a charged roller instead of a corona wire, but the principle is still the same.) As the drum revolves, the printer shines a tiny laser beam across the surface to discharge certain points. In this way, the laser "draws" the letters and images to be printed as a pattern of electrical charges or what's called an electrostatic image. Some laser printers work with the charges reversed meaning a positive electrostatic image on a negative background.

After the pattern is set, the printer coats the drum with a positively charged fine black powder called toner. Since it has a positive charge, the toner clings to the negative discharged areas of the drum, but not to the positively charged "background."

With the powder pattern "glued," the drum rolls over a sheet of paper, which is moving along a belt below. Before the paper rolls under the drum, it is given a negative charge by the transfer corona wire (charged roller). This charge is stronger than the negative charge of the electrostatic image, so the paper can pull the toner powder away. Since it is moving at the same

speed as the drum, the paper picks up the image pattern exactly. To keep the paper from clinging to the drum, the detach corona wire discharges it right after it picks up the toner.

Finally, the printer passes the paper through the fuser, a pair of heated rollers. Because toner is made partly from plastic, the loose toner powder melts, fusing with the fibers in the paper as the paper passes through these rollers. The fuser rolls the paper to the output tray, and you have your finished page! The fuser also heats up the paper itself, of course, which is why pages are always hot when they come out of a laser printer.

After depositing toner on the paper, the drum surface passes the discharge lamp. This bright light exposes the entire photoreceptor surface, erasing the electrical image. The drum surface then passes the charge corona wire, which reapplies the positive charge. The excess toner and electrostatic charges are cleaned off of the photoconductor so that it is ready for the next cycle.

Paper Transport Mechanism

- **Paper Tray/Feeder** – Both of these are different methods of releasing paper, however a paper tray tends to hold more paper than a feeder does. The feeder is usually hidden behind a secret panel somewhere above the paper tray.
- **Rollers** - A set of rollers pull the paper in from the tray or feeder and advance the paper when the print drum is ready for another pass.
- **Paper Feed Stepper Motor** – Powers the rollers to move the paper in the exact increment needed to ensure a continuous image is printed. After the image is transferred to the paper, the paper transport mechanism deposits the print in the output hopper.
- **Paper Jam** - Improperly loaded or wrinkled paper will cause a paper jam. As the name implies, a paper jam is paper that's jammed up somewhere in the paper transport mechanism. To clear a paper jam, you may need to open the paper tray, remove the toner cartridge, and release an access panel or two just to get to the piece of wayward paper.

Paper Transport Mechanism



Figure 2. Placing the paper in the paper tray.



Figure 3. Make sure the paper is pushed down under the paper release tabs in the paper tray. Otherwise paper jams will abound.



Figure 4. To clear a paper jam, you may need to open access panels to get access to the wayward print.

The Controller

Before a laser printer can do anything, it needs to receive the page data and figure out how it's going to put everything on the paper. This is the job of the printer controller. The printer controller is the laser printer's main onboard computer. It talks to the host computer (for example, your PC) through a communications port, such as a parallel port or USB port. At the start of the printing job, the laser printer establishes with the host computer how they will exchange data. The controller may have to start and stop the host computer periodically to process the information it has received.

In an office, a laser printer will probably be connected to several separate host computers, so multiple users can print documents from their machine. The controller handles each one separately, but may be carrying on many "conversations" at the same time.

For the printer controller and the host computer to communicate, they need to speak the same page description language. Nowadays, there may be hundreds of different fonts to choose from, and you wouldn't think twice about printing a complex graphic. To handle all of this diverse information, the printer needs to speak a more advanced language.

The primary printer languages are Hewlett Packard's Printer Command Language (PCL) and Adobe's Postscript. Both of these languages describe the page in vector form as mathematical values of geometric shapes and not as a series of dots like a bitmap image. The printer itself takes the vector images and converts them into a bitmap page. With this system, the printer can receive elaborate, complex pages, featuring any sort of font or image. Because the printer creates the bitmap image itself, it can use its maximum printer resolution.

Tech Note: Some printers use a graphical device interface (GDI) format instead of a standard PCL. In this system, the host computer creates the dot array itself, so the controller doesn't have to process anything. The computer workstation just sends the dot instructions on to the laser itself.

In most laser printers, the controller must organize all of the data it receives from the host computer. This includes all of the commands that tell the printer what to do, what paper to use, how to format the page, how to handle the font, etc. For the controller to work with this data, it is important that the data is received in the right order.

Once the data is structured, the controller begins putting the page together. It sets the text margins, arranges the words and places any graphics. When the page is arranged, the raster image processor (RIP) takes the page data, either as a whole document or piece by piece, and breaks it down into an array of tiny dots. The printer needs the page in this form so the laser can write it out on the photoreceptor drum.

In most laser printers, the controller saves all print-job data in printer memory. This lets the controller put different printing jobs into a line or queue. This feature allows the printer to work

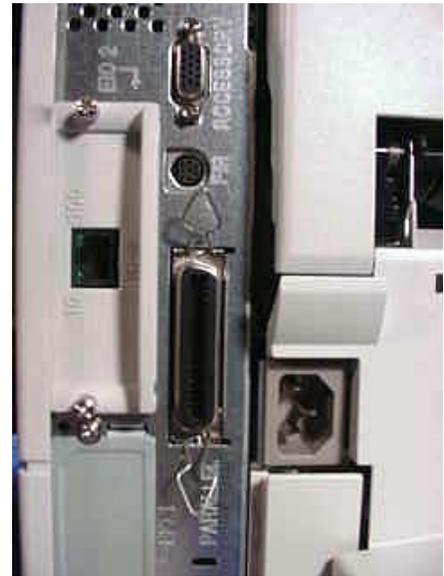


Figure 5. Ports on the back of the printer facilitate connections to power, LAN, accessories, and a computer workstation. Data ports may include RJ45, Centronics Parallel, fiber optic, or infrared connections.

through the jobs one at a time. This saves time when printing multiple copies of a document because the host computer only has to send the data once while it prints from memory.

The Laser

Since it actually draws the page, the printer's laser system or laser scanning assembly must be incredibly precise. The traditional laser scanning assembly includes a:

- Laser
- Movable Mirror
- Lens

The laser receives the page data in tiny dots that make up the text and images one horizontal line at a time. As the beam moves across the drum, the laser emits a pulse of light for every dot to be printed, and no pulse for every dot of empty space.

The laser doesn't actually move the beam itself. It bounces the beam off a movable mirror instead. As the mirror moves, it shines the beam through a series of lenses. This system compensates for the image distortion that may be caused by the varying distance between the mirror and points along the drum. The laser assembly moves in only one plane, horizontally. After each horizontal scan, the printer moves the photoreceptor drum up a notch so the laser assembly can draw the next line. A small print-engine computer synchronizes all of this perfectly.

Tech Note: Some laser printers use a strip of light emitting diodes (LEDs) to write the page image, instead of a single laser. Each dot position has its own dedicated light, which means the printer has one, set print resolution. These systems cost less to manufacture than true laser assemblies, but they produce inferior results. Typically, you'll only find light emitting diodes in less expensive printers.

Toner

The toner is one of the most distinctive features of a laser printer. In laser printers, the paper grabs the ink rather than the printer applying the ink to the paper. However, toner really isn't ink at all. Toner is an electrically charged powder with two main ingredients: pigment and plastic. Pigment provides the coloring that fills in the text and images. This pigment is blended into plastic particles, so it melts when it passes through the heat of the fuser. The toner firmly binds to the fibers in almost any type of paper, which means the text won't smudge or bleed easily.

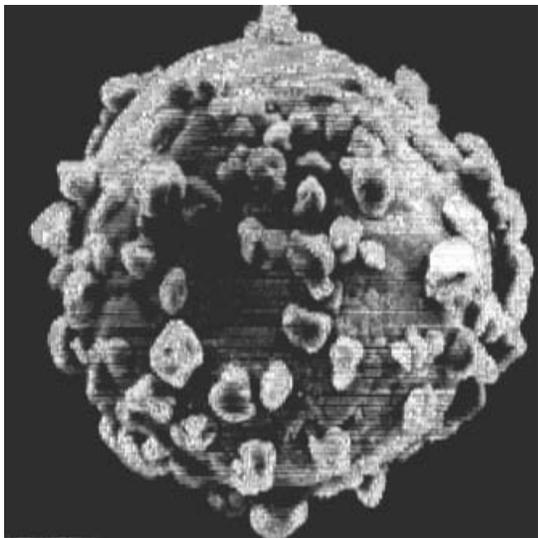


Figure 6. Magnified view of a plastic developer bead coated with even smaller toner particles.

So how does the printer apply this toner to the electrostatic image on the drum? The powder is stored in the toner hopper, a small container built into a removable casing. The printer gathers the toner from the hopper with the developer unit. The "developer" is actually a collection of small, negatively charged magnetic beads. These beads are attached to a rotating metal roller, which moves them through the toner in the toner hopper.

Because they are negatively charged, the developer beads collect the positive toner particles as they pass through. The roller then brushes the beads past the drum assembly. The electrostatic image has a stronger negative charge than the developer beads, so the drum pulls the toner particles away from the developer bead.

The drum then moves over the paper, which has an even stronger charge and the paper grabs the toner. After collecting the toner, the paper is immediately discharged by the detachable corona wire. At this point, the only thing keeping the toner on the page is gravity. If you were to blow on the page, you would completely lose the image. The page must pass through the fuser to attach the toner. Internal quartz tube lamps heat the fuser rollers, so the plastic in the toner melts, as it passes through, and binds to the paper.

To keep the toner from collecting on the fuser rollers, the fuser rollers must be coated with Teflon, the same non-stick material that keeps your breakfast from sticking to the bottom of the frying pan.

Replacing the Toner Cartridge:

The process differs slightly from printer to printer. Some printers have separate drum unit, toner hopper, and developer units. However, most printers feature these three components in one replaceable unit called a toner cartridge.

1. Open the front cover of the laser printer and remove the drum unit assembly if it is not housed in the toner cartridge.
2. Place the drum unit on a flat surface and remove the toner cartridge with your left hand while pushing the lock lever down with your right hand (if there is a lock lever).
3. Open the new toner cartridge and rock it from side to side 5 or 6 times to break up the toner in the cartridge. Be sure to keep in horizontal.
4. Remove the protective cover strip to release the toner.
5. Install the new toner cartridge into the drum unit assembly... again – Only if the drum unit is separate from the toner cartridge. If there is one, the lock lever will lift automatically when the toner cartridge is correctly installed.
6. Clean the primary corona wire inside the drum unit by gently sliding the blue tab back and forth from the left and right a few times. Be sure to place the blue tab back in its original position before reinstalling the drum unit assembly.
7. Reinstall the drum unit and close the front cover of the Laser Printer.

Color Printers

Most commercial laser printers used to be limited to monochrome printing (black writing on white paper). But now, there are lots of color laser printers on the market.

The Laser Toner Cartridge



Figure 7. Open the laser printer to locate the toner cartridge. Firmly grab the cartridge from the center and pull it out.



Figure 8. Handle the cartridge carefully as you remove it and place it off to the side.



Figure 9. With the cartridge removed you can see the path of the paper as it's transported through the printer.



Figure 10. The toner cartridge combines the toner hopper, developer and drum assembly as one replaceable unit.

Color printers work the same way as monochrome printers, except they go through the entire printing process four times - one pass for cyan (blue), one for magenta (red), one for yellow and one for black. By combining these four colors of toner in varying proportions, you can generate the full spectrum of colors.

There are several different ways of doing this. Some models have four toner and developer units on a rotating wheel. The printer lays down the electrostatic image for one color and puts that toner unit into position. It then applies this color to the paper and goes through the process again for the next color. Some printers add all four colors to a plate before placing the image on paper. Some more expensive printers actually have a complete printer unit, a laser assembly, a drum and a toner system for each color. The paper simply moves past the different drumheads, collecting all the colors in a sort of assembly line.

Advantages of a Laser Printer

The main advantages of laser printers are speed, precision and economy. A laser can move very quickly, allowing it to "write" with much greater speed than an ink jet printer. Because the laser beam has a standardized diameter, it can draw more precisely, without spilling any excess ink.

Laser printers tend to be more expensive than inkjet printers, but it doesn't cost as much to keep them running. Toner powder is cheap and lasts a long time, while you can use up expensive ink cartridges very quickly. Offices and school classrooms typically use a laser printer because they print long text documents and often print in large amounts.

When they were first introduced, laser printers were too expensive to use as personal printers. Now, laser printers are much more affordable. Basic Laser Printer models are now available for just a bit more than a nice Inkjet Printer.

Review:

Essentially, a laser printer consists of a laser assembly, a drum system and a toner system. Using all of these parts, a laser is used to apply toner to the paper, through negatively and positively charged particles, resulting in text and images printed onto a page. While other types of printers are available, laser printers produce printouts of the highest quality and can handle numerous jobs at once, making them ideal for offices school classrooms.



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Exercise 1 - Laser Printer Technology

Instructions:

Study the content carefully before attempting the questions listed below. Consider using other information sources as well. Periodicals, reference materials, and the Internet are great resources to find the answers to the technical problems you're going to face when servicing computers.

Name:	
Period:	
Date:	

Speaking of resources... Let's save some of our natural resources. Rather than printing out the entire lesson, print out only the worksheet. Study the lesson on-screen and then record your answers on this worksheet. When you're finished, return the worksheet to your supervisor for evaluation. Be sure to complete this assignment before moving onto the next.

Research Resources:

Company	Web Site	Description
How Stuff Works	www.howstuffworks.com	How stuff works provides the basic process of how laser printers work in order to produce a printed text document or image.
Micro Mechanic	www.mimech.com	Micro Mechanic provides a simple understanding of the process Laser printers use to produce various documents.
Ufix-it	www.ufix-it.com	Ufix-it is a website that will help users to properly correct many problems that one might have with their printer.
Imprints UCSD Print Resource Center	http://imprints.ucsd.edu/lps/troubleshoot.html	UCSD provides solutions to various problems that may occur with a laser printer, as well as other types of printers available.

Questions:

1. ✓ Research and develop a detailed definition for each of the following terms. Many words have multiple definitions... Some of which may have nothing to do with the field of Computer Service and Support. Make sure your definition falls within the context of this lesson. Refer to the list of Research Resources and Required Materials as well as other materials you feel are appropriate. Write your definitions on the reverse side of this worksheet or a separate piece of paper with each definition being two sentences or more.

- | | | |
|-----------------|---------------------------|-----------------------|
| ✓ Drum Assembly | ✓ Printer Controller | ✓ Toner Hopper |
| ✓ Toner | ✓ Photoreceptor | ✓ Developer Unit |
| ✓ Fuser | ✓ Laser Scanning Assembly | ✓ Monochrome Printing |

2. ✓ Why is static electricity considered the key to how a laser printer works?

3. ✓ What typically causes paper jams?

4. ✓ What type of material is the drum unit made of?

- 5.√ Put these steps of the laser printing process in order?
- Charge
 - Clean
 - Develop
 - Fuse
 - Transfer
 - Write
- 6.√ What's the name of the component that receives page data and figures out how it's going to be put on the paper?
- 7.√ What are the primary printer languages used by laser printers?
- 8.√ What laser printer component moves the laser beam across the surface of the photoreceptor drum?
- 9.√ Instead of a laser, some laser printers use _____ as a light source?
- 10.√ What is toner made of?
- 11.√ The prints your laser printer produces smudge very easily. In fact, the toner just falls off the page. The likely cause is a defective _____ .
- 12.√ The prints your laser printer produces have streaks of missing toner running from the top to the bottom of the page. The likely cause is a scratched _____ roller?
- 13.√ What are three advantages of laser printers?



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Exercise 2 – Laser Printer PMI

Exercise Objective:

In this exercise, you'll perform Preventive Maintenance Inspection of a laser printer. You'll collect the appropriate tools together and use them correctly to complete this exercise.

Name:	
Period:	
Date:	

Discussion of Fundamentals:

We perform the preventive maintenance inspection (PMI) to preserve the reliability of the equipment we use. Through careful inspection, cleaning, and maintenance our computer workstations will perform better and longer than those that are neglected. The PMI also allows us to detect serious problems before they occur and perhaps prevent system crashes and reduce equipment down time.

Required Materials:

- Work Order
- Equipment ID Tag
- Laser Printer
- Spray and Wipe Cleaner
- Soft-Bristled Brush
- Stiff-Bristled Brush
- Cotton Swabs
- Lint-Free Towels
- Compressed Air
- Vacuum
- PC Technician Toolkit
- Adhesive Remover

Procedure:

Complete each of the following steps in this exercise. When you see a ✓... That's an indication that you need to do something. This is an **abbreviated** guide to performing a preventive maintenance inspection of a laser printer. Refer to the previous section for details on how to complete each step. Print out this exercise and use it to keep track of your progress while performing the following steps.

A. INITIAL PRINTER INSPECTION

Preparation: Printer completely assembled and operational. Power **OFF**. Rings, watches and jewelry must be removed.

1. ✓ Make sure you have a valid work order. If the item is in the shop make sure it has an Repairable Item Tag on it.
2. ✓ Inspect for any broken or missing parts. Record the parts and a description of their defect on the work order.
3. ✓ Rattle test the printer. Remove paper, detach any removable covers, and slowly rock the printer while listening for loose or traveling parts inside the case. Investigate and report your findings to your supervisor if the printer fails the rattle test.

CAUTION: Most printers manufactured for the United States operate on 110 Volts **ONLY**. If you plug the printer into the wrong voltage you will destroy it. Examine the ID plate and attach the correct power cord to the printer.

4. ✓ Connect the printer to a power source.
5. ✓ Reassemble the printer and make sure the printer is loaded with paper.
6. ✓ Perform a printer Self-Test.

Tech Note: Most printers have a built-in self-test function. Different manufacturers use different combinations of keys to activate the self-test. Consult the printer's user's manual to determine how to run the printer self test. **NOTE:** Most printers incorporate safety interlock switches into the covers and lids. The printer must be assembled before it can print.

- 7.√ Check the quality of the print for darkness and clarity. If the quality of the print is light or broken up, chances are the cartridge may be old and need changing.
- 8.√ Turn the printer's power off.

() **Supervisor Check**

B. INTERNAL CLEANING

Preparation: Printer completely open disassembled. Remove the toner cartridge and paper tray. Open all access panels. Power **OFF and Unplugged**. Rings, watches and jewelry must be removed.

- 1.√ Use compressed air and a soft bristle brush to remove dust and debris from inside the printer.
- 2.√ Clean the primary corona wire inside the toner cartridge.
- 3.√ Carefully reassemble the printer.

() **Supervisor Check**

C. EXTERNAL CLEANING

Preparation: Printer completely assembled and operational. Power **OFF and Unplugged**. Rings, watches and jewelry must be removed.

- 1.√ Clean the lids, covers, and external surfaces with spray and wipe cleaner.
- 2.√ Clean air vents with a stiff bristled brush or cotton swab wet with spray and wipe cleaner.
- 3.√ Remove any unnecessary labels or tape using adhesive remover.
- 4.√ Wipe down all surfaces cleaning off streaks and smudges.
- 5.√ Reassemble the printer and load with paper.

() **Supervisor Check**

D. OPERATIONAL TESTING

Preparation: Printer completely assembled and operational. Connect the printer to a computer workstation. Turn the Power **ON**. Make sure the printer is **ON-LINE**. Rings, watches and jewelry must be removed.

- 1.√ Boot-up the computer into Windows
- 2.√ Go to the Start menu and open Settings.
- 3.√ Open the Control Panel and open Printers.

Tech Note: If the printer you want to test isn't listed in the printer panel you'll have to add it. Select "Add a Printer" and following the installation instructions. Ask your supervisor for help if you need it.

- 4.√ Right click the printer that you would like to test.
- 5.√ Open Properties
- 6.√ Make sure you are under "General" tab.
- 7.√ Click on "Print Test Page"

() Supervisor Check

E. PRINTER INSTALLATION

Preparation: Printer completely assembled, tested, and operational. Connect the printer to a computer workstation. Turn the Power **ON**. Make sure the printer is **ON-LINE**. Rings, watches and jewelry must be removed.

- 1.√ Position the printer as it would be used by the customer.
- 2.√ Boot-up the computer into Windows and setup the printer in the Control Panel if necessary.
- 3.√ Organize all data and power cables in a neat and orderly fashion.
- 4.√ Gather tools and supplies and throw away used materials.
- 5.√ Wipe down the work area one last time.
- 6.√ Have the customer sign the Work Order once the job is complete.
- 7.√ Return the completed Work Order to the dispatcher.

() Supervisor Check



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Exercise 3 – Laser Features/Service

Exercise Objective:

In this exercise you will compare the features of various laser printers. At the end of this exercise, you should be familiar with the variations in key features between laser printers.

Name:	
Period:	
Date:	

Discussion of Fundamentals:

You really need to become familiar with printer specs and how to recognize a quality product. You'll also need to recognize the serviceable components and how to set it up for use with a computer workstation.

Research Resources:

Company	Web Site	Description
Hewlett Packard	http://www.hp.com	Hewlett Packard Printer Information
Cannon	http://www.canon.com	Cannon Printer Information
Epson	http://www.epson.com	Epson Printer Information

Required Materials:

- Laser Printer
- Printer User Manual
- Internet Access

Procedure:

Complete each of the following steps in this exercise. When you see a ✓... That's an indication that you need to do something. Print out this exercise and use it to keep track of your progress while performing the following steps.

A. Laser Printer Features

1. ✓ Study the printer manual to obtain the following specifications of a laser printer in your classroom:

Specification	Value
Speed Of The Printer (Pages Per Minute):	
Max Resolution:	
Max Colors:	
RAM:	
Type Of Toner Cartridges:	
Price:	

- 2.√ Visit the websites of several laser printer manufactures and select the laser printer that delivers “the best bang for the buck”. Complete the table below.

Specification	Value
Manufacturer:	
Model Number:	
Speed of the printer (pages per minute):	
Max Resolution:	
Max Colors:	
RAM:	
Type of Toner Cartridges:	
Price:	

() **Supervisor Check**

B. Laser Printer Service

- 1.√ Exam the inside of a laser printer looking for removable or replaceable parts.
- 2.√ Practice removing and reinserting the toner cartridge and paper.
- 3.√ Open the printer to the point where you could clear a paper jam any along the paper transport path.
- 4.√ Clean the primary corona wire inside the toner cartridge.
- 5.√ Print out a test page using the printer’s self-test feature.

() **Supervisor Check**