OBJECTIVES

This chapter helps you to prepare for the Core Hardware module of the A+ Certification examination by covering the following objectives within the "Preventive Maintenance" section.

3.1. Identify the purpose of various types of preventive maintenance products and procedures, and when to use/perform them.

Content may include the following:

- **Liquid cleaning compounds**
- **Types of materials to clean contacts and connections**
- **Vacuum-out systems, power supplies, and fans**

▶ An important part of most computer service jobs is providing preventive maintenance for computer equipment, or teaching users the proper steps to care for their equipment.

3.2. Identify procedures and devices for protection within the computing environment, including people, technology, and the ecosystem.

Content may include the following:

- **UPSs (uninterruptible power supplies) and suppressors**
- **Determining the signs of power issues**
- **Proper methods of storage of components for future use**

Potential hazards and proper safety procedures relating to lasers.

Content may include the following:

- **High-voltage equipment**
- **Power supply**
- **CRTs**

CHAPTER 3

3.0 Preventive Maintenance

OBJECTIVES

Special disposal procedures complying with environmental guidelines.

- **Batteries**
- **CRTs**
- **Toner kits/cartridges**
- **Chemical solvents and cans**
- **MSDS (Material Safety Data Sheet)**

ESD (electrostatic discharge) precautions and procedures.

- **What ESD can do as well as how it may be apparent or hidden**
- **Common ESD protection devices**
- **Situations that could present a danger or hazard**

▶ Computer technicians should be aware of potential environmental hazards and know how to prevent them from becoming a problem.

▶ Safety is an issue in every profession. Technicians should be aware of the potential hazards associated with certain areas of the computer and with certain types of peripheral equipment.

▶ Concerns for the world environment are at their highest. Many of the materials used in the construction of computer-related equipment can be harmful. Also, many of the products used to service computer equipment can have an adverse effect on the environment. Therefore, the technician should be aware of requirements associated with the disposal of this equipment and these materials.

▶ PC repair personnel should be aware of the causes and damaging effects of ESD so that they can prevent its occurrence.

OUTLINE

STUDY STRATEGIES

To prepare for the Preventive Maintenance objective of the Core Hardware exam:

- Read the objectives at the beginning of this chapter.
- Study the information in this chapter.
- Review the objectives listed earlier in this chapter.
- Perform any step-by-step procedures in the text.
- Use the ExamGear test engine on the CD that accompanies this book for additional Review and Exam Questions concerning this material.
- Review the Test Tips scattered throughout the chapter and make certain that you are comfortable with each point.

INTRODUCTION

This domain requires the test taker to show knowledge of safety and preventive maintenance. With regard to safety, it includes the potential hazards to personnel and equipment when working with lasers, high-voltage equipment, ESD, and items that require special disposal procedures that comply with environmental guidelines.

With regard to preventive maintenance, this includes knowledge of preventive maintenance products, procedures, environmental hazards, and precautions when working on microcomputer systems. Questions from this domain account for 5% of the Core Hardware test.

PREVENTIVE MAINTENANCE

- 3.1 Identify the purpose of various types of preventive maintenance products and procedures, and when to use/perform them.

The A+ Core Hardware objective 3.1 states that the test taker should be able to "identify the purpose of various types of preventive maintenance products and procedures, and when to use/perform them."

It has long been known that one of the best ways to fix problems with complex systems is to prevent them before they happen. This is the concept behind preventive maintenance procedures. Breakdowns never occur at convenient times. By planning for a few minutes of nonproductive activities, hours of repair and recovery work can be avoided.

Cleaning

TEST TIP

Know the common ways to clean various computer components.

Cleaning is a major part of keeping a computer system healthy. Therefore, the technician's tool kit also should contain a collection of cleaning supplies. Along with hand tools, it needs a lint-free, soft cloth (chamois) for cleaning the plastic outer surfaces of the system.

To clean outer surfaces, just use a soap-and-water solution, followed by a clear water rinse. Take care to make sure that none of the liquid splashes or drips into the inner parts of the system. A damp cloth is

easily the best general-purpose cleaning tool for use with computer equipment.

Follow the cleaning by applying an antistatic spray or *antistatic solution* to prevent the buildup of static charges on the components of the system. A solution composed of 10 parts water and 1 part common household fabric softener makes an effective and economical antistatic solution. To remove dust from the inside of cabinets, a small paintbrush is handy.

Another common problem is the buildup of oxidation, or corrosion, at electrical contact points. These buildups occur on electrical connectors and contacts, and can reduce the flow of electricity through the connection. You can follow some simple steps to keep corrosion from becoming a problem. The easiest way to prevent corrosion is to observe the correct handling procedures for printed circuit boards and cables, as shown in Figure 3.1. Never touch the electrical contact points with your skin, because the moisture on your body can start corrosive action.

Even with proper handling, some corrosion may occur over time. You can remove this *oxidation buildup* in a number of ways. The oxide buildup can be sanded off with emery cloth, rubbed off with a common pencil eraser or special solvent-wipe, or dissolved with an electrical-contact cleaner spray. Socketed devices should be reseated (removed and reinstalled to establish a new electrical connection) as a part of an anticorrosion cleaning. However, they should be handled according to the *metal-oxide semiconductor* (MOS) handling guidelines in this chapter to make certain that no static discharge damage occurs.

If you use the emery cloth or rubber eraser to clean your contacts, always rub toward the outer edge of the board or connector to prevent damage to the contacts. Rubbing the edge may lift the foil from the PC board. Printed circuit board connectors are typically very thin. Therefore, rub hard enough to remove only the oxide layer. Also, take time to clean up any dust or rubber contamination generated by the cleaning effort.

Cleaning other internal components, such as disk drive read/write (R/W) heads, can be performed using lint-free foam swabs and isopropyl alcohol or methanol. It is important that the cleaning

TEST TIP

Know what types of materials/techniques can be used to clean different areas of the computer system.

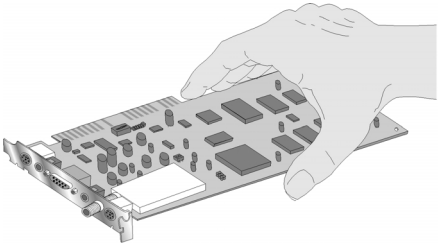

FIGURE 3.1
How to handle a PC board.

solution be one that dries without leaving residue. The following tools and equipment are recommended for a well-prepared computer-repair toolbox:

- Assorted flat-blade screwdrivers
- Assorted Phillips screwdrivers
- Assorted small nut drivers
- Assorted small torx bit drivers
- Needle-nose pliers
- Diagonal pliers
- Contact cleaner
- Foam swabs
- Tweezers
- Cleaning supplies
- Magnifying glass
- Clip leads
- IC extractors

Preventive Maintenance Procedures

The environment around a computer system, and the manner in which the computer is used, determines greatly how many problems it will have. Occasionally dedicating a few moments of care to the computer can extend its *mean time between failures* (MTBF) period considerably. This activity, involving maintenance not normally associated with a breakdown, is called *preventive maintenance* (PM).

TEST TIP

Know what environmental conditions, or activities, are most likely to lead to equipment failures.

The following sections describe PM measures for the various areas of the system.

As with any electronic device, computers are susceptible to failures caused by dust buildup, rough handling, and extreme temperatures.

Over time, dust builds up on everything it can gain access to. Many computer components generate static electrical charges that attract dust particles. In the case of electronic equipment, dust forms an

insulating blanket that traps heat next to active devices and can cause them to overheat. Excessive heat can cause premature aging and failure. The best dust protection is a dust-tight enclosure. However, computer components tend to have less than dust-tight seals. Power-supply and microprocessor fans pull air from outside through the system unit.

Another access point for dust is uncovered expansion slot openings. Missing expansion slot covers adversely affect the system in two ways. First, the missing cover permits dust to accumulate in the system, forming the insulating blanket that causes component overheating. Second, the heat problem is complicated further by the fact that the missing slot cover interrupts the designed airflow patterns inside the case, causing components to overheat due to missing or inadequate airflow.

TEST TIP

Be aware of the effect that missing expansion slot covers have on the operation of the system unit.

Smoke is a more dangerous cousin of dust. Like dust particles, smoke collects on all exposed surfaces. The residue of smoke particles is sticky and will cling to the surface. In addition to contributing to the heat buildup problem, smoke residue is particularly destructive to moving parts such as floppy disks, fan motors, and so forth.

Dust buildup inside system components can be taken care of with a soft brush. A static-free vacuum also can be used to remove dust from inside cases and keyboards. Be sure to use a static-free vacuum, because normal vacuums are natural static generators. The static-free vacuum has special grounding to remove the static buildup it generates. Dust covers also are helpful in holding down dust problems. These covers are just placed over the equipment when not in use and removed when the device is needed.

TEST TIP

Know that computer vacuums have special grounding to dissipate static buildup that can damage computer devices.

Rough handling is either a matter of neglect or a lack of knowledge about how equipment should be handled. Therefore, overcoming rough-handling problems requires that technicians be aware of proper handling techniques for sensitive devices, such as hard disk drives and monitors, and that they adjust their component-handling practices to compensate.

Identifying and controlling heat buildup problems can require some effort and planning. Microcomputers are designed to run at normal room temperatures. If the ambient temperature rises above about 85°F, heat buildup can become a problem. High humidity also can lead to heat-related problems.

To combat heat problems, make sure that the area around the system is uncluttered so that free airflow around the system can be maintained. Make sure the power supply's fan is operational. If not, replace the power-supply unit. Likewise, be sure that the microprocessor fan is plugged in and operational. It is very easy for a high-speed microprocessor to fry if its fan fails. A good rule of thumb is to install a fan on any microprocessor running above 33MHz.

If heat buildup still exists, make sure that the outer cover is secured firmly to the machine and that all the expansion slot covers are in place. These items can disrupt the designed airflow characteristics of the case. Finally, add an additional case fan to draw more air through the system unit.

Protecting Monitors

The PM associated with video display monitors basically consists of periodic cleaning, dusting, and good, common-sense practices around the monitor. The monitor's screen and cabinet should be dusted frequently and cleaned periodically. Dust and smoke particles can build up very quickly around the monitor's screen, because of the presence of static charges on its face. When cleaning the screen, use caution to avoid scratching its surface and, in the case of antiglare screens, to preserve its glare-reduction features.

Avoid aerosol sprays, solvents, and commercial cleaners because they can damage the screen and cabinet. The simple cleaning solution, described earlier, also is fine for cleaning the monitor. Make sure that the monitor's power cord is disconnected from any power source before washing. The monitor's screen should be dried with a soft cloth after rinsing.

The monitor should not be left on for extended periods with the same image displayed onscreen. Over a period of time, the image will become permanently "burned" into the screen. If it is necessary to display the same information onscreen for a long period of time, turn the intensity level of the monitor down or install a *screen saver program* to alter the screen image periodically.

Inside the monitor's housing are very dangerous voltage levels (in excess of 25,000 volts; more than enough to kill or badly injure someone). Therefore, you should remove the monitor's outer cabinet only if you are fully qualified to work on CRT-based units. Even if

the monitor has been turned off and unplugged for a year, it may still hold enough electrical potential to be deadly. Figure 3.2 shows the areas of the monitor that should be avoided (if you must work inside its housing).

Video display monitors often include a tilt/swivel base that enables the users to position it at whatever angle is most comfortable. This offers additional relief from eyestrain by preventing the users from viewing the display at an angle. Viewing the screen at an angle causes the eyes to focus separately, which places strain on the eye muscles.

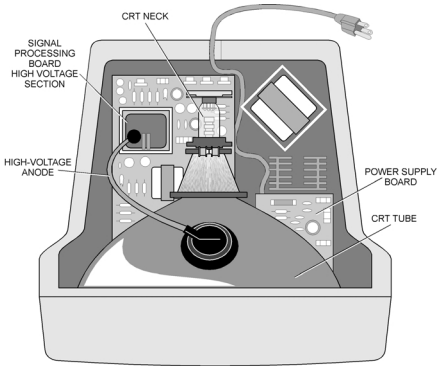

FIGURE 3.2
Caution areas inside the monitor.

Protecting Hard Disk Drives

Hard disk drives do not require much preventive maintenance, because the R/W heads and disks are enclosed in sealed, dust-tight compartments. However, you can do some things to optimize the performance and life span of hard disk systems. Rough handling is responsible for more hard disk drive damage than any other factor.

Never move the drive while you can hear its disk spinning. The disk is most vulnerable during startup and shutdown, when the heads are not fully flying. Even a small jolt during these times can cause a great deal of damage to both the platters and the R/W heads. If the drive must be moved, a waiting period of one full minute should be allotted after turning off the system.

If the drive is to be transported, or shipped, make sure to pack it properly. The forces exerted on the drive during shipment may be great enough to cause the R/W heads to slap against the disk surfaces, causing damage to both. Pack the drive unit in an oversized box, with *antistatic foam* all around the drive. You also may pack the drive in a box-within-a-box configuration, once again using foam as a cushion. Figure 3.3 illustrates this concept.

At no time should the hard drive's housing, which protects the platters, be removed in open air. The drive's disks and R/W heads are sealed in the airtight housing under a vacuum. The contaminants floating in normal air will virtually ruin the drive. If the drive malfunctions, the electronic circuitry and connections may be tested; but when it comes to repairs within the disk chamber, factory service or a professional service facility with a proper clean room is a must!

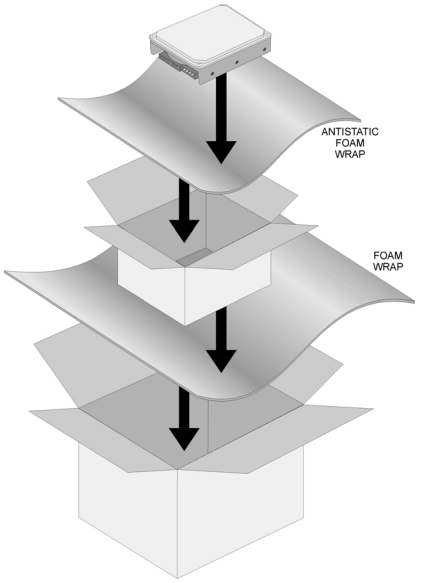

FIGURE 3.3
Proper packing of a hard drive for shipment.

To recover quickly from hardware failures, operator mistakes, and acts of nature, some form of software backup is essential with a hard disk system. The most common backup for larger systems is high-speed, streaming tape cartridges, which can automatically back up the contents of the entire disk drive on magnetic tape. In the event of data loss on the disk, a full reinstall from the tape is possible in a matter of a few minutes.

Backups also may be kept on disks. However, the volume of data stored on modern hard disks would require a tremendous number of floppy disks to back up. The floppy disks also would need to be stored. Other high-volume disk-based devices, such as optical drives and removable hard drives, have become attractive ways to back up the contents of large hard drives. CD-R and CD-RW drives provide an attractive option for storing limited amounts (680MB) of critical data. Their high capacities allow large amounts of information to be written on a single disc. The major drawback of using a CD-R disc is that after the disc has been written to, it cannot be erased or reused. Figure 3.4 depicts various backup methods. In any case, failure to maintain backups will eventually result in a great deal of grief when the system goes down because of a hardware or software failure.

TEST TIP

Be aware of the precautions that should be employed with storing system backups.

Copies of the system backup should be stored in a convenient, but secure place. In the case of secure system backups, such as client/server networks, the backup copies should be stored where the network administrators can have access to them, but not the general public (for instance, in a locked file cabinet). Left unsecured, these copies could be used by someone without authority to gain access the system, or to its data. Even Emergency Repair Disks associated with Windows NT and Windows 2000 should be stored in a secure location. These disks also can be used by people other than administrators to gain access to information in client/server networks. Many companies maintain a copy of their backup away from the main site. This is done for protection in case of disasters such as fire.

The operation of hard drives can slow down with general use. Files stored on the drive may be erased and moved, causing parts of them to be scattered around the drive. This is referred to as file fragmentation and causes the drive to reposition the R/W heads more often during read and write operations, thereby requiring more time to complete the process.

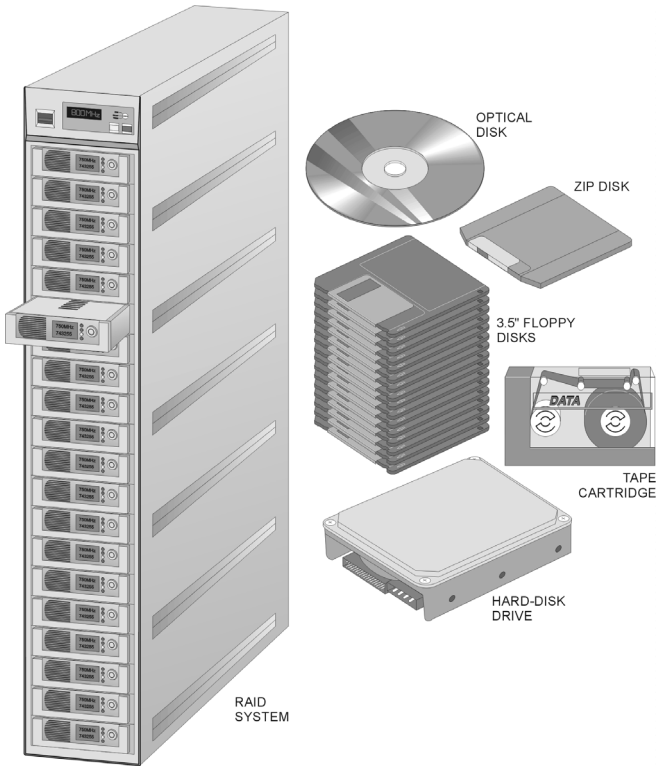

FIGURE 3.4
Data backup systems.

A number of hard disk drive software utilities are designed to optimize and maintain the operation of the hard disk drive. They should be used as part of a regular preventive maintenance program. The primary HDD utilities are the Check Disk, ScanDisk, Defrag, Backup, and antivirus utilities that have been available with different version of DOS and Windows since early MS-DOS versions. These are discussed in more detail in the Chapter 7, "1.0 Operating System Fundamentals," and in Chapter 9, "3.0 Diagnosing and Troubleshooting."

Protecting Floppy Disk Drives

Unlike hard disk drives, floppy drives are at least partially open to the atmosphere, and they may be handled on a regular basis. This opens the floppy disk drive to a number of maintenance concerns not found in hard disk drives. Also, the removable disks are subject

to extremes in temperature, exposure to magnetic and electromagnetic fields, bending, and airborne particles that can lead to information loss.

The mechanical mechanisms of the floppy drive should never be positioned by hand. The weighted drive spindle and the track-zero sensor may be accessible with the drive's outer cover removed. Moving these mechanisms by hand can cause the R/W heads to drag across the disk, damaging the heads and disk surfaces.

Protecting Disks

Because the disk stores information in the form of magnetized spots on its surface, it is only natural that external magnetic fields will have an adverse effect on the stored data. Never bring disks near magnetic-field-producing devices, such as CRT monitors, television sets, or power supplies. They also should never be placed on or near appliances such as refrigerators, freezers, vacuum cleaners, and other equipment containing motors. Any of these can alter the information stored on the disk.

Proper positioning of the drive, and proper connection of peripheral interface cables, helps to minimize noise and *radio frequency interference* (RFI). RFI can cause the drive to operate improperly. Magnetic fields generated by power supplies and monitors can interfere with the magnetic recording on the disk. The drive and signal cables should be positioned away from these magnetic-field sources. Never bring magnets near the drive unit.

Another major cause of floppy disk failures is surface contamination. Several preventive measures minimize disk contamination and lengthen the life expectancy of your disks. Although the disk is enclosed in a protective case, whose liner sweeps contaminants from its surface, enough dust particles can collect to overpower the liner over time. Take care to never touch the exposed surfaces of the disk. Store disks in their protective envelopes and keep your computer area as clean and free from dust as possible.

There should be no smoking around the computer. Residues from tobacco smoke are a problem for floppy disk drives because they tend to build up on the exposed surfaces of both the disks and the drive. These deposits are detrimental to both the drive and the disk, because they gum up the close-tolerance mechanics of the drive and cause scratching to occur on the disk surface and the faces of the

R/W heads. This makes the heads less effective in reading and writing information to and from the disk and eventually leads to failure of the disk and the drive.

Additional ways to protect your disks include storing them in a cool, dry, clean environment, out of direct sunlight. Excessive temperature causes the disk and its jacket to warp. Take care when inserting the disk into the drive so as not to damage its jacket or the drive's internal mechanisms.

NOTE

Floppy Disks Wear Out The fact that the R/W heads ride directly on the floppy disk surface produces a certain amount of contamination and wear on the disk and heads. During read and write operations, the abrasion between the heads and disk cause some of the oxide coating on the disk to be transferred to the head. This makes the head less effective in reading and writing operations, and eventually leads to the failure of the disk.

Maintaining the Floppy Drive

So far, each preventive action has involved the disk. Users can perform two procedures on the disk drive to ward off bigger maintenance problems: routine cleaning of the R/W heads (to remove oxide buildup), and periodic disk drive speed tests and adjustments when necessary.

Cleaning R/W heads removes residue and oxide buildup from the face of the head to ensure accurate transfer of data from the head to the disk. Two accepted methods may be used to clean the heads: special *head-cleaning disks*, and manual cleaning of the heads.

Head-cleaning disks are convenient to use, but some precautions must be taken when using them. There are, basically, two types of cleaning disks: dry (abrasive) disks, and wet (chemical) disks. Abrasive head-cleaning disks remove buildup as the disk spins in the drive. This is similar to using sandpaper to remove paint from a surface. These disks can be damaging to the head if used for too long of a time.

The dry disk must be left in the drive just long enough to remove the buildup on the head, but not long enough to scratch the head surface. Because of the difficulties of timing this operation, manufacturers have developed nonabrasive, cloth-covered disks that are used with a solvent solution. Depending on the type of kit you purchase, the disk may be premoistened or may come with a separate solvent solution that must be applied to the disk before cleaning, as illustrated in Figure 3.5.

The opportunity for abrasion of the head still exists with this type of cleaning disk. However, it is not as great as with the dry disks. Consult the instructions that come with the cleaning kit for proper usage and cleaning-time duration.

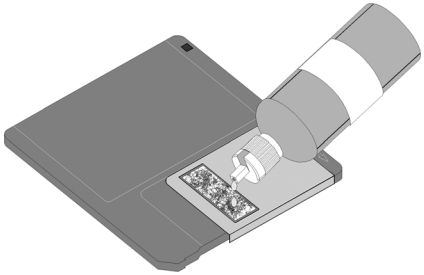

FIGURE 3.5
FDD cleaning disks.

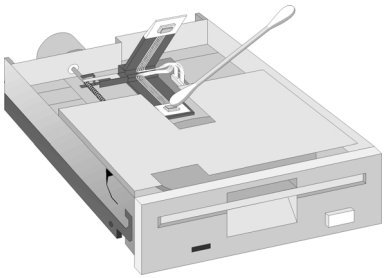

FIGURE 3.6
Cleaning the R/W heads.

A somewhat more complicated way to clean R/W heads is to clean them manually, as depicted in Figure 3.6. This operation involves removing the cover of the drive, gaining access to the R/W heads, and cleaning them manually with a swab that has been dipped in alcohol. Although this may appear to be a lot of work compared to the cleaning disk, manual cleaning is much safer for the drive. This is particularly true when combined with other cleaning, oiling, and inspection work. Together, these steps provide an excellent preventive maintenance program that should ensure effective, long-term operation of the drive.

The cleaning solution can be isopropyl alcohol, methanol, or some other solvent that does not leave a residue when it dries. Common cotton swabs are not recommended for use in manual cleaning because they tend to shed fibers. These fibers can contaminate the drive and, in certain circumstances, damage the R/W heads. Instead, cellular foam swabs or lint-free cloths are recommended for manual head cleaning. Using either cleaning method, the interval of time between head cleanings depends on several factors, such as the relative cleanliness of your computer area and how often you use your disk drive. A good practice is to clean the heads after 40 hours of disk drive operation. If read/write errors begin to appear before this time elapses, more frequent cleaning, or the use of higher quality disks, may be required.

Protecting Input Devices

Input peripherals generally require very little in the way of preventive maintenance. An occasional dusting and cleaning should be all that's really required.

You should, however, keep a few common-sense items in mind when using input devices; these should prevent damage to the device and ensure its longevity.

The keyboard's electronic circuitry is open to the atmosphere and should be vacuumed, as described in Figure 3.7, when you are cleaning around your computer area. Dust buildup on the keyboard circuitry can cause its ICs to fail due to overheating. To remove dirt and dust particles from inside the keyboard, disassemble the keyboard and carefully brush particles away from the board with a soft brush. A lint-free swab can be used to clean between the keys. Take

care not to snag any exposed parts with the brush or swab. To minimize dust collection in the keyboard, cover your keyboard when not in use.

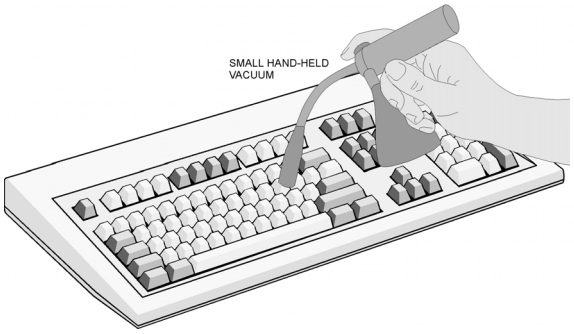

FIGURE 3.7
Cleaning the keyboard.

TEST TIP

Remember that dust can settle into the keyboard through the cracks between the keys.

Never set keyboards or pointing devices on top of the monitor or near the edge of the desk where they may fall off. To prevent excessive wear on special keys, avoid applications and game programs that use keys in a repetitive manner. For these applications, use an appropriate pointing device, such as a mouse or joystick, for input.

When using a mouse, keep its workspace clear, dry, and free from dust. Remove and clean the trackball periodically. Use a lint-free swab to clean the X and Y trackball rollers inside the mouse, as described in Figure 3.8.

As with detachable keyboards, keep the connecting cables of all pointing devices out of harm's way.

TEST TIP

Know how to clean a trackball mouse.

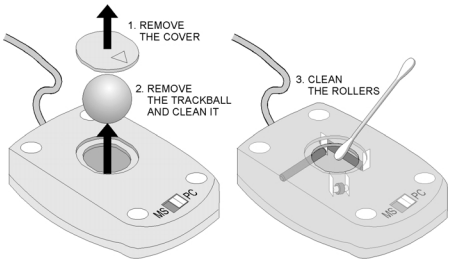

FIGURE 3.8
Cleaning the rollers in a trackball mouse.

Scheduling Preventive Maintenance

There is no perfect PM schedule; however, the following is a reasonable schedule that can be used to effectively maintain most computer equipment. The schedule is written from the point of view of a personal computer. Because this is an outside maintenance perspective, some of the steps need to be shared with the daily users. As a matter of fact, the users carry out most of the daily and weekly PM activities.

Daily Activities

Back up important data from the unit. This can be done by using floppy disks, backup tape, another network drive, or some other backup media. Check computer ventilation to make sure that papers and other desk clutter are not cutting off airflow to the unit. Check for other sources of heat buildup around the computer and its peripherals. These sources include the following:

- Direct sunlight from an outside window
- Locations of portable heaters in the winter
- Papers/books piled up around the equipment

Weekly Activities

Clean the outside of the computer and its peripheral equipment. Wipe the outsides of the equipment with a damp cloth. The cloth can be slightly soapy. Wipe dry with an antistatic cloth. Clean the display screen using a damp cloth with the antistatic solution described earlier in this chapter. An antistatic spray also can be used for static-buildup prevention.

Run **CHKDSK/F** on all hard drives to locate and remove any lost clusters from the drives. This utility is available in all the Microsoft operating systems including Windows 9x, Windows NT, and Windows 2000. The **CHKDSK** command must be run from the command prompt in all versions. Run a current virus-check program to check for hard drive infection. Back up any revised data files on the hard drive. Inspect the peripherals (mice, keyboard, and so on) and clean them if needed.

Monthly Activities

Clean the inside of the system. Use a long-nozzle vacuum cleaner attachment to remove dust from the inside of the unit. Wipe the nozzle with antistatic solution before vacuuming. A soft brush also can be used to remove dust from the system unit.

Clean the inside of the printer using the same equipment and techniques as those used with the system unit. Check system connections for corrosion, pitting, or discoloration. Wipe the surface of any peripheral card's edge connectors with a lubricating oil, to protect it from atmospheric contamination.

Vacuum the keyboard. Clean the X and Y rollers in the trackball mouse using a lint-free swab and a noncoating cleaning solution.

Defragment the system's hard drive using the Defrag utility. Remove unnecessary temporary (TMP) files from the hard drive. Check software and hardware manufacturers for product updates that can remove problems and improve system operation. Back up the entire hard disk drive.

Semi-Annual Activities

Every six months, perform an extensive PM check. Apply an antistatic wash to the entire computer/peripheral work area. Wipe down books, desktop, and other workspace surfaces with antistatic solution. Disconnect power and signal cords and cables from the system's devices and reseat them. Clean the inside of the printer. Run the printer's self-tests.

Use a software diagnostic package to check each section of the system. Run all system tests available, looking for any hint of pending problems.

Annual Activities

Reformat the hard drive by backing up its contents and performing a high-level format. If the drive is an MFM, RLL, or ESDI drive, a low-level format also should be performed annually. Reinstall all the application software from original media and reinstall all user files from the backup system. Check all floppy disks in the work area with a current *antivirus program*.

Clean the R/W heads in the floppy drive using a lint-free swab. Cotton swabs have fibers that can hang up in the ceramic insert of the head and damage it. Perform the steps outlined in the "Monthly Activities" and "Semi-Annual Activities" sections.

Although this is a good model PM schedule, it is not the definitive schedule. Before establishing a firm schedule, consider several other points, including any manufacturers' guidelines for maintaining the equipment. Read the User Manuals of the various system components and work their suggested maintenance steps into the model.

Over time, adjust the steps and frequency of the plan to effectively cope with any environmental or usage variations. After all, the objective is not to complete the schedule on time, it is to keep the equipment running and profitable.

SYSTEM PROTECTION

▶ 3.2 Identify procedures and devices for protecting against environmental hazards.

The A+ Core Hardware objective 3.2 states that the test taker should be able to "identify procedures and devices for protecting against environmental hazards."

As this A+ objective indicates, computer technicians should be aware of potential environmental hazards and know how to prevent them from becoming a problem. A good place to start checking for environmental hazards is from the incoming power source. The following sections deal with power-line issues and solutions.

Power-Line Protection

Typical power-supply variations fall into two categories:

- **Transients.** An overvoltage condition; sags are undervoltage conditions. Overvoltage conditions can be classified as *spikes* (measured in nanoseconds) or as *surges* (measured in milliseconds).
- **Sags.** Sags can include *voltage sags* and *brownouts*. A voltage sag typically lasts only a few milliseconds; a brownout can last for a protracted period of time.

NOTE

Avoid Power Variations Digital systems tend to be sensitive to power variations and losses. Even a very short loss of electrical power can shut a digital computer down, resulting in a loss of any current information that has not been saved to a mass-storage device.

TEST TIP

Be aware of how undervoltage and overvoltage situations are categorized (that is, time lengths).

The effects of these power-supply variations are often hard to identify as power issues. Brownouts and power failures are easy to spot because of their duration. However, faster acting disturbances can cause symptoms not easily traced to the power source. Spikes can be damaging to electronic equipment, damaging devices such as hard drives and modems. Other occurrences will just cause data loss. Sags may cause the system to suddenly reboot because it thinks the power has been turned off. These disturbances are relatively easy to detect because they typically cause lights in the room to flicker.

In general, if several components go bad in a short period of time, or if components go bad more often than usual at a given location, these are good indicators of power-related issues. Likewise, machines that crash randomly and often could be experiencing power issues. If "dirty" power problems are suspected, a voltage-monitoring device should be placed in the power circuit and left for an extended period of time. These devices observe the incoming power over time and produce a problem indicator if significant variations occur.

Surge Suppressors

Inexpensive *power-line filters*, called *surge suppressors*, are good for cleaning up dirty commercial power. These units passively filter the incoming power signal to smooth out variations. You must consider two factors when choosing a surge suppresser:

- Clamping speed
- Clamping voltage

These units protect the system from damage, up to a specified point. However, large variations, such as surges created when power is restored after an outage, can still cause considerable data loss and damage. In the case of startup surges, making sure that the system is turned off, or even disconnected from the power source, until after the power is restored is one option. In the case of a complete shutdown, or a significant sag, the best protection from losing programs and data is an *uninterruptible power supply* (UPS).

TEST TIP

Know what type of devices will protect systems from minor power sags and power surges.

TEST TIP

Know what type of device prevents power interruptions that can corrupt data.

Uninterruptible Power Supplies

Uninterruptible power supplies are battery-based systems that monitor the incoming power and kick in when unacceptable variations occur in the power source. The term UPS is frequently used to describe two different types of power backup systems.

The first is a *standby power system*, and the second is a truly uninterruptible power system. Figure 3.9 depicts a typical UPS system.

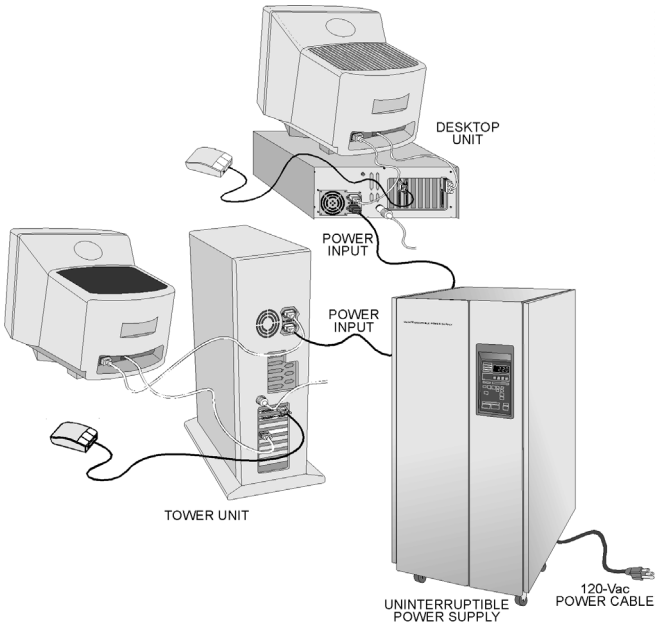

FIGURE 3.9
UPS systems.

The standby system monitors the power input line and waits for a significant variation to occur. The batteries in this unit are held out of the power loop and draw only enough current from the AC source to stay recharged. When an interruption occurs, the UPS senses it and switches the output of the batteries into an inverter circuit that converts the DC output of the batteries into an AC current, and voltage, that resembles the commercial power supply. This power signal is typically applied to the computer within 10 milliseconds.

The uninterruptible systems do not keep the batteries offline. Instead, the batteries and converters are always actively attached to the output of UPS. When an interruption in the supply occurs, no switching of the output is required. The battery/inverter section just continues under its own power. Figure 3.10 shows how a UPS connects into a system.

Standby systems do not generally provide a high level of protection from sags and spikes. They do, however, include additional circuitry to minimize such variations. Conversely, an uninterruptible system is an extremely good power-conditioning system. Because it always sits between the commercial power and the computer, it can supply a constant power supply to the system.

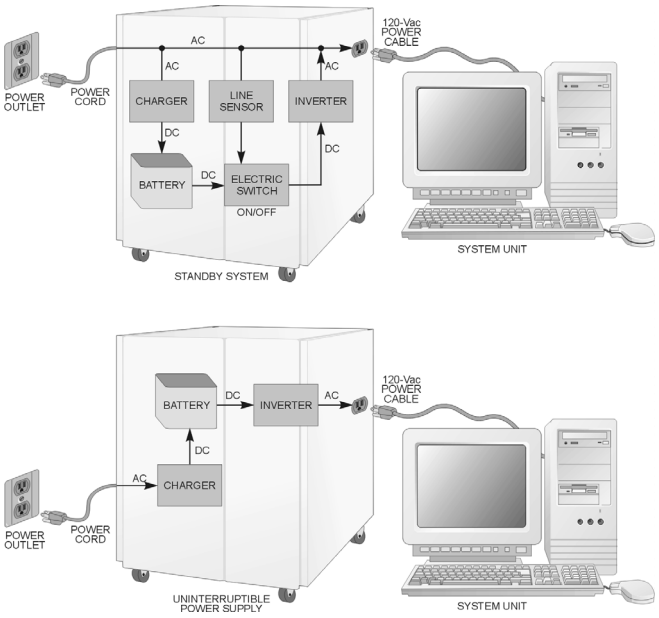

FIGURE 3.10
Connecting the UPS in the system.

When dealing with either type of UPS system, the most important rating to be aware of is its *volt-ampere (VA) rating*. The VA rating indicates the capability of the UPS system to deliver both voltage (V) and current (A) to the computer, simultaneously. This rating differs from the device's *wattage rating*, and the two should not be used interchangeably.

The wattage power rating is a factor of multiplying the voltage and current use, at any particular time, to arrive at a power-consumption value. The VA rating is used in AC systems because peak voltage and current elements do not occur at the same instant. This condition is referred to as being out-of-phase with each other, and makes it slightly more difficult to calculate power requirements. In general, always make sure that the UPS system has a higher wattage capability than the computer requires, and likewise, that the VA rating of the UPS is higher than that required by the computer.

High-power-consumption peripheral devices, such as laser printers, should not be connected directly to the UPS. These devices can overload the UPS and cause data loss.

The other significant specification for UPS systems is the length of time they can supply power. Because the UPS is a battery-powered device, it uses an *ampere-hour rating*. This is the same time notation system used for automobile batteries and other battery-powered systems. The rating is obtained by multiplying a given current drain from the battery, for a given amount of time. (That is, a battery capable of sustaining 1.5 amps of output current for 1 hour would be rated at 1.5 amp-hours.)

TEST TIP

Remember that nonessential peripheral devices should not be connected to UPS supplies.

The primary mission of the UPS is to keep the system running when a power failure occurs (usually, long enough to conduct an orderly shutdown of the system). Because it is a battery-based system, it cannot keep the system running indefinitely. For this reason, you should not connect nonessential, power-hungry peripheral devices, such as a laser printer, to the UPS supply. If the power goes out, it is highly unlikely that you will really have to print something before shutting the system down. If the UPS is being used to keep a critical system in operation during the power outage, the high current drain of the laser printer would severely reduce the length of time that the UPS could keep the system running.

Protection During Storage

The best storage option for most computer equipment is the original manufacturer's box. These boxes are designed specifically to store and transport the device safely. They include form-fitting protective foam to protect the device from shock hazards. The device is normally wrapped in a protective *antistatic bag* or wrapper to defeat the effects of ESD.

Printed circuit boards are normally shipped on a thin piece of antistatic foam. The board is typically placed solder-side down on the foam. Both the foam and the board are placed in an antistatic bag and then into a storage box.

Hard disk drives are usually placed directly into a static bag and then placed in a thick foam box. The foam box is then inserted into a storage carton. FDDs typically receive less padding than HDD units do.

Monitors, printers, scanners, and other peripheral equipment should be stored in their original boxes, using their original packing foam and protective storage bag. The contours in the packing foam of

these devices are not generally compatible from model to model or device to device. If the original boxes and packing materials are not available, make sure to use sturdy cartons and cushion the equipment well on all sides before shipping.

All electronic devices should be stored in dry, cool areas away from heat sources and direct sunlight. Low-traffic areas also are preferable for storage because there is less chance of incidental damage from people and/or equipment passing by.

TEST TIP

Know that the best device for transporting computer equipment is the original manufacturer's packaging, including the antistatic foam and bags used to pack it.

HAZARDS AND SAFETY PROCEDURES

▶ 3.2 Identify the potential hazards and proper safety procedures relating to lasers.

A subsection of the A+ Core Hardware objective 3.2 states that the test taker should be able to identify "the potential hazards and proper safety procedures relating to lasers" and high-voltage equipment.

This discussion starts with safety procedures when dealing with high-voltage areas of the computer. Note the following:

- Lasers can cause blindness.
- High-voltage equipment (such as the power supply and CRT) can cause electrocution.

Avoiding High-Voltage Hazards

Most IBM compatibles have only two potentially dangerous areas. One of these is inside of the CRT display; the other is inside the power-supply unit. Both of these areas contain lethal voltage levels. Both of these areas reside in self-contained units, however, and you will normally not be required to open either unit.

As a matter of fact, you should never enter the interior of a CRT cabinet unless you have been trained specifically to work with this type of equipment. The tube itself is dangerous if accidentally cracked. In addition, extremely high voltage levels (in excess of 25,000 volts) can be present inside the CRT housing, even up to a year after electrical power has been removed from the unit.

TEST TIP

Be aware of the voltage levels present inside a CRT cabinet.

Never open the power-supply unit either. Some portions of the circuitry inside the power supply carry extremely high voltage levels and have very high current capabilities.

Generally, no open shock hazards are present inside the system unit. However, you should not reach inside the computer while power is applied to the unit. Jewelry and other metallic objects do pose an electrical threat, even with the relatively low voltage present in the system unit.

Never have liquids around energized electrical equipment. It is a good idea to keep food and drinks away from all computer equipment at all times. Before cleaning around the computer with liquids, make certain to unplug all power connections to the system, and its peripherals. When cleaning external computer cabinets with liquid cleaners, take care to prevent any of the solution from dripping or spilling into the equipment.

Do not defeat the safety feature of three-prong power plugs by using two-prong adapters. The equipment ground of a power cord should never be defeated or removed. This plug connects the computer chassis to an earth ground through the power system. This provides a reference point for all the system's devices to operate from and supplies protection for personnel from electrical shock. In defeating the ground plug, a very important level of protection is removed from the equipment.

Periodically examine the power cords of the computer and peripherals for cracked or damaged insulation. Replace worn or damaged power cords promptly. Never allow anything to rest on a power cord. Run power cords and connecting cables safely out of the way so that they do not become trip or catch hazards. Remove all power cords associated with the computer and its peripherals from the power outlet during thunder or lightning storms.

Do not apply liquid or aerosol cleaners directly to computer equipment. Spray cleaners on a cloth and then apply the cloth to the equipment. Freon-propelled sprays should not be used on computer equipment, because they can produce destructive electrostatic charges.

Check equipment vents to see that they are clear and have ample airspace to allow heat to escape from the cabinet. Never block these vents, and never insert or drop objects into them.

Avoiding Laser and Burn Hazards

Laser printers contain many hazardous areas. The laser light can be damaging to the human eye. In addition, there are multiple high-voltage areas in the typical laser printer and a high-temperature area to contend with.

The technician is normally protected from these areas by interlock switches built in to the unit. It is often necessary to bypass these interlocks, however, to isolate problems. When doing so, proper precautions must be observed, such as avoiding the laser light, being aware of the high temperatures in the fuser area, and taking proper precautions with the high-voltage areas of the unit. The laser light is a hazard to eyesight, the fuser area is a burn hazard, and the power supplies are shock hazards. More information about these areas of laser printers is presented in Chapter 5, "5.0 Printers."

Another potential burn hazard is the printhead mechanism of a dot-matrix printer. During normal operation, it can become hot enough to be a burn hazard if touched.

Because computers have the potential to produce these kinds of injuries, it is good practice to have a well-stocked first-aid kit in the work area. In addition, a *Class-C fire extinguisher* should be on hand. Class-C extinguishers are the type specified for use around electrical equipment. You can probably imagine the consequences of applying a water-based fire extinguisher to a fire with live electrical equipment around. The class, or classes, that the fire extinguisher is rated for are typically marked on its side.

TEST TIP

Know the areas of the computer system that are dangerous for personnel and how to prevent injury from these areas.

You may think that there's not much chance for a fire to occur with computer equipment, but this is not so. Just let a capacitor from a system board blow up and have a small piece land in a pile of packing materials in the work area. It becomes a fire!

This covers the major safety precautions and considerations that you need to be aware of while working on computer equipment. Most of all, use common sense and sound safety practices around all electrical equipment.

TEST TIP

Remember the type of fire extinguisher that must be used with electrical systems, such as a PC.

DISPOSAL PROCEDURES

▶ 3.2 Identify items that require special disposal procedures complying with environmental guidelines.

A subsection of the A+ Core Hardware objective 3.2 states that the test taker should be able to identify "items that require "special disposal procedures complying with environmental guidelines."

As with any mechanical device, a computer eventually becomes obsolete in the application for which it was originally intended. Newer machines, with improved features, arise to replace earlier models. And slowly, but surely, components fail and get replaced. Then comes the question: What do I do with the old stuff? Can it just be placed in the garbage bin so that it is hauled to the landfill and buried?

In today's world of environmental consciousness, you might not think so. After all, computers and peripherals contain some environmentally unfriendly materials.

Most computer components contain some level of *hazardous substances*. Printed circuit boards consist of plastics, precious metals, fiberglass, arsenic, silicon, gallium, and lead. CRTs contain glass, metal, plastics, lead, barium, and rare earth metals. Batteries from portable systems can contain lead, cadmium, lithium, alkaline manganese, and mercury.

Although all these materials can be classified as hazardous materials, so far there are no widespread regulations when it comes to placing them in the landfill. Conversely, local regulations concerning acceptable disposal methods for computer-related components should always be checked before disposing of any electronic equipment.

TEST TIP

Remember that toner cartridges from a laser printer should be recycled.

Laser-printer toner cartridges can be refilled and recycled. This should be done only in draft-mode operations, however, where very good resolution is not required. Ink cartridges from inkjet printers also can be refilled and reused. Like laser cartridges, they can be very messy to refill and often do not function as well as new cartridges do. In many cases, the manufacturer of the product will have a policy of accepting spent cartridges.

For both batteries and cartridges, the desired method of disposal is *recycling*. It should not be too difficult to find a drop site that recycles these products. On the other hand, even nonhazardous Subtitle D dump sites can handle the hardware components if need be. Subtitle D dump sites are nonhazardous solid-waste dump sites that have been designed to meet EPA standards set for this classification. These sites are designed to hold hazardous materials safely.

TEST TIP

Remember that the proper disposal method for batteries is to recycle them.

Fortunately, several charitable organizations around the country take in old computer systems and refurbish them for various applications. Contact your local chamber of commerce for information about such organizations. On the Internet, you also can find several computer disposal organizations that take old units and redistribute them. In addition, a few companies will dispose of your old computer components in an "environmentally friendly" manner—for a fee.

In addition to the computer parts that provide hazardous materials, many of the cleaning substances used on computer equipment can be classified as hazardous materials. When it comes to disposing of the chemical solvents used to clean computers the containers they come in, it will normally be necessary to clear these items with the local waste-management agencies before disposing of them. Many dump sites will not handle free liquids. Free liquids are substances that can pass through a standard paint filter. If the liquid passes through the filter, it is a free liquid and cannot be disposed of in the landfill. Therefore, solvents and other liquid cleaning materials must be properly categorized and disposed of at an appropriate type of disposal center.

All hazardous materials are required to have *Material Safety Data Sheets* (MSDS) that accompany them when they change hands. They also are required to be on hand in areas where hazardous materials are stored and commonly used. The MSDS contains information about the following:

- What the material is
- Its hazardous ingredients
- Its physical properties
- Fire and explosion data
- Reactivity data
- Spill or leak procedures

- Health-hazard information
- Any special-protection information
- Any special-precaution information

The supplier of the hazardous material must provide this information sheet. If you supply this material to a third party, you also must supply the MSDS for the material. The real reason for the sheets is to inform workers and management about hazards associated with the product and how to handle the product safely. It also provides instructions about what to do if an accident occurs involving the material. For this reason, employees should know where the MSDSs are stored in their work area.

ELECTROSTATIC DISCHARGE

TEST TIP

Remember what the acronym ESD stands for.

▶ 3.2 Identify ESD (electrostatic discharge) precautions and procedures, including the use of ESD protection devices.

A subsection of the A+ Core Hardware objective 3.2 states that the test taker should be able to identify "ESD (electrostatic discharge) precautions and procedures."

The first way to avoid *electrostatic discharge* (ESD) is to be able to identify when and why it occurs.

Identifying and Avoiding Electrostatic Discharge

NOTE

What Is an ESD Electrostatic discharges are the most severe form of *electromagnet interference* (EMI). The human body can build up static charges that range up to 25,000 volts. These buildups can discharge very rapidly into an electrically grounded body or device. Placing a 25,000V surge through any electronic device is potentially damaging to it.

Static can easily discharge through digital computer equipment. The electronic devices used to construct digital equipment are particularly susceptible to damage from ESD. As a matter of fact, ESD is the most damaging form of electrical interference associated with digital equipment.

The following are the most common causes of ESD:

- Moving people
- Low humidity (hot and dry conditions)
- Improper grounding

- Unshielded cables
- Poor connections
- Moving machines

Elementary school teachers demonstrate the principles of static to their students by rubbing different materials together. When people move, the clothes they are wearing rub together and can produce large amounts of electrostatic charge on their bodies. Walking across carpeting can create charges in excess of 1,000 volts. Motors in electrical devices, such as vacuum cleaners and refrigerators, generate high levels of ESD.

ESD is most likely to occur during periods of low humidity. If the relative humidity is below 50%, static charges can accumulate easily. ESD generally does not occur when the humidity is above 50%. Anytime the charge reaches around 10,000 volts, it is likely to discharge to grounded metal parts.

Although ESD will not hurt humans, it will destroy certain electronic devices. The high-voltage pulse can burn out the inputs of many IC devices. This damage may not appear instantly. It can build up over time and cause the device to fail. Electronic logic devices, constructed from MOS materials, are particularly susceptible to ESD. The following section describes the special handling techniques that should be observed when working with equipment containing MOS devices.

IN THE FIELD

HIGH VOLTAGE, LOW RISK TO HUMANS

You may be a little confused by the warning about the lethal 25,000 volts present inside the monitor and the statement that the 10,000 to 25,000 volts of ESD are not harmful to humans. The reason for this is the difference in current-delivering capabilities created by the voltage. For example, the circuitry in the monitor and the power supply is capable of delivering amps of current, whereas the current-producing capabilities of the electrostatic charge are less than a thousandth of that. Therefore, the 120V AC, 1-amp current produced by the power-supply unit is lethal, whereas the 25,000V DC, microamp current produced by ESD is not.

TEST TIP

Memorize the conditions that make ESD more likely to occur.

TEST TIP

Be aware that compressed air can be used to blow dust out of components and that it does not create ESD.

TEST TIP

Memorize conditions and actions that produce electrostatic discharge.

TEST TIP

Remember that the current capabilities of electrical devices establish the potential danger levels associated with working around them.

MOS-Handling Techniques

In general, MOS devices are sensitive to voltage spikes and static-electricity discharges. This can cause many problems when you have to replace MOS devices, especially *complementary-symmetry metal-oxide semiconductor* (CMOS) devices. The level of static electricity present on your body is high enough to destroy the inputs of a CMOS device if you touch its pins with your fingers.

To minimize the chances of damaging MOS devices during handling, special procedures have been developed to protect them from static shock. ICs are generally shipped and stored in special conductive-plastic tubes or trays. You may want to store MOS devices in these tubes, or you may just ensure their safety by inserting the IC's leads into aluminum foil or antistatic (conductive) foam—not styrofoam. PC boards containing static-sensitive devices are normally shipped in special antistatic bags. These bags are good for storing ICs and other computer components that may be damaged by ESD. They also are the best way to transport PC boards with static-sensitive components.

Professional service technicians employ a number of precautionary steps when they are working on systems that may contain MOS devices. These technicians normally use a *grounding strap*, like the one depicted in Figure 3.11. These antistatic devices may be placed around the wrists or ankle to *ground* the technician to the system being worked on. These straps release any static present on the technician's body and pass it harmlessly to ground potential.

TEST TIP

Know when not to wear an antistatic wrist strap.

Antistatic straps should never be worn while working on higher voltage components, such as monitors and power-supply units. Some technicians wrap a copper wire around their wrist or ankle and connect it to the ground side of an outlet. This is not a safe practice, because the resistive feature of a true wrist strap is missing. As an alternative, most technician's work areas include *antistatic mats* made out of rubber or other antistatic materials that they stand on while working on the equipment. This is particularly helpful in carpeted work areas, because carpeting can be a major source of ESD buildup. Some antistatic mats have ground connections that should be connected to the safety ground of an AC power outlet.

To avoid damaging static-sensitive devices, the following procedures will help to minimize the chances of destructive static discharges:

- Because computers and peripheral systems may contain a number of static-sensitive devices, before touching any components inside the system, touch an exposed part of the chassis or the power-supply housing with your finger, as illustrated in Figure 3.12. Grounding yourself in this manner ensures that any static charge present on your body is removed. Use this technique before handling a circuit board or component. Of course, be aware that this technique works safely only if the power cord is attached to a grounded power outlet. The ground plug on a standard power cord is the best tool for overcoming ESD problems.
- Do not remove ICs from their protective tubes (or foam packages) until you are ready to use them. If you remove a circuit board or component containing static-sensitive devices from the system, place it on a conductive surface, such as a sheet of aluminum foil.
- If you must replace a defective IC, use a soldering iron with a grounded tip to extract the defective IC and while soldering the new IC in place. Some of the ICs in computers and peripherals are not soldered to the printed circuit board. Instead, an IC socket is soldered to the board, and the IC is just inserted into the socket. This allows for easy replacement of these ICs.

  In the event that you must replace a hard-soldered IC, you may want to install an IC socket along with the chip. Be aware that normal operating vibrations and *temperature cycling* can degrade the electrical connections between ICs and sockets over time. This gradual deterioration of electrical contact between chips and sockets is referred to as chip creep. It is a good practice to reseat any socket-mounted devices when handling a printed circuit board. Before removing the IC from its protective container, touch the container to the power supply of the unit in which it is to be inserted.
- Some devices used to remove solder from circuit boards and chips can cause high static discharges that may damage the good devices on the board. The device in question is referred to as a solder-sucker, and is available in antistatic versions for use with MOS devices.

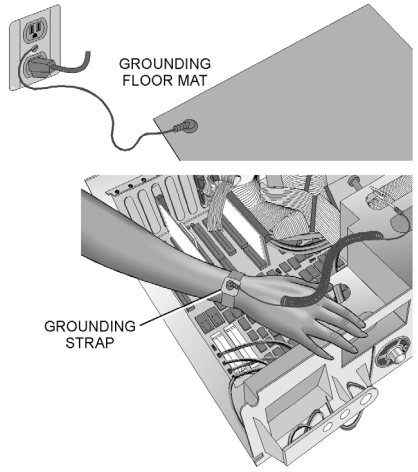

FIGURE 3.11
Typical antistatic devices.

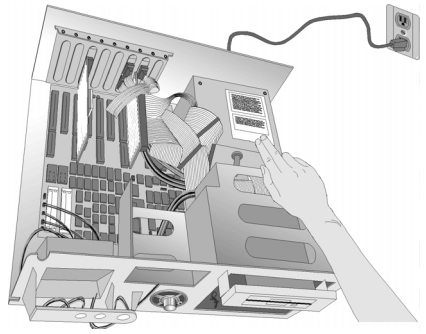

FIGURE 3.12
Discharging through the power-supply unit.

TEST TIP

Be aware of the effects that temperature cycling can have on socket-mounted devices.

- Use antistatic sprays or solutions on floors, carpets, desks, and computer equipment. An antistatic spray or solution, applied with a soft cloth, is an effective deterrent to static.
- Install static-free carpeting in the work area. You also can install an antistatic floor mat as well. Install a conductive tabletop to carry away static from the work area. Use antistatic table mats.
- Use a room humidifier to keep the humidity level above 50% in the work area. Figure 3.13 summarizes proper IC handling procedures.

FIGURE 3.13
Antistatic precautions.

Understanding Grounds

The movement of the electrical current along a conductor requires a path for the current to return to its source. In early telegraph systems and even modern power-transmission systems, the earth provides a return path and, hypothetically, produces an electrical reference point of absolute zero. Figure 3.14 depicts this type of ground.

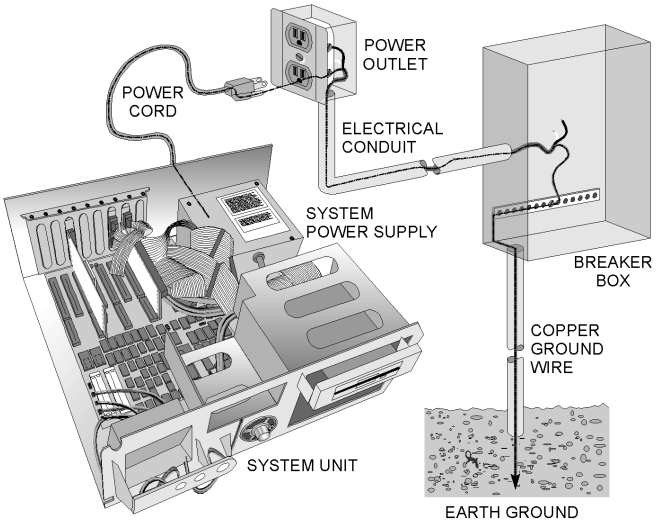

FIGURE 3.14
Power-transmission system.

Many electronic circuits use an actual conductor as a return path. This type of ground is referred to as a *signal ground*. Electronic devices also may contain a third form of ground called *chassis ground*, or *protective ground*. In any event, ground still remains the reference point from which most electrical signals are measured. In the case of troubleshooting computer components, measurements referenced to ground may be made from the system unit's chassis.

The other measurement reference is the signal ground point, on the printed circuit board, where the test is being performed. This point is not too difficult to find in a circuit board full of ICs, because most DIP-style chips use the highest numbered pin for the positive supply voltage and the last pin on the pin-1 side of the chip as the ground pin. Figure 3.15 depicts this type of ground. Some caution should be used with this assumption, because not all ICs use this pin for ground. If you examine a number of ICs and connectors on the board, however, you should be able to trace the ground foil and use it as a reference.

NOTE

What Are Grounds The term *ground* is often a source of confusion for novices, because it actually encompasses a collection of terms. Generically, ground is just any point from which electrical measurements are referenced. However, the original definition of ground actually referred to the ground. This ground is called *earth ground*.

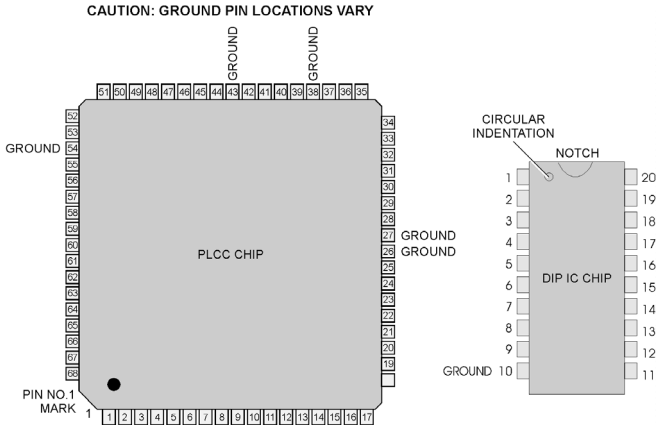

FIGURE 3.15
Grounds on IC chips.

TEST TIP

Remember that ESD is destructive and EMI is not.

TEST TIP

Know the best protection for a computer system during an electrical storm.

Grounding is an important aspect of limiting EMI in computer systems. Left unchecked, EMI can distort images on the video display, interfere with commercial communication equipment (such as radios and televisions), and corrupt data on floppy disks. In addition, EMI can cause signal deterioration and loss caused by improper cable routing. If a signal cable is bundled with a power cord, radiation from the power cord may be induced into the signal cable, affecting the signals that pass through it. Good grounding routes the induced EMI signals away from logic circuitry and toward ground potential, preventing it from disrupting normal operations. Unlike ESD, which is destructive, the effects of EMI can be corrected without damage.

Because the computer system is connected to an actual earth ground, it should always be turned off and disconnected from the wall outlet during electrical storms. This includes the computer and all its peripherals. The electrical pathway through the computer equipment can be very inviting to lightning on its way to earth ground. The extremely high electrical potential of a lightning strike is more than any computer can withstand.

CHAPTER SUMMARY

The focus of this chapter was to present important points for inclusion in preventive maintenance programs associated with personal computer systems. The first section of the chapter dealt with typical cleaning chores. It also featured preventive maintenance procedures for the system's different components. A suggested PM schedule also was presented. This is time-proven information and should always be shared freely with customers.

The second major section of the chapter focused on environmental hazards that affect the operation of computer equipment. The majority of this section dealt with problems that revolve around fluctuations in the computer's in-coming power line. Different types of universal power supplies were discussed, along with other power-line conditioning devices. The remainder of the section discussed proper storage methods for computer components.

Potentially hazardous areas of the computer and its peripherals were presented in the third major section of the chapter. Although not an intrinsically unsafe environment, some areas of a computer system can be harmful if approached unawares.

CHAPTER SUMMARY

Disposal of old and defective equipment and cleaning materials was discussed in the fourth section of the chapter. MSDS records were also introduced.

The final section of the chapter described the danger and causes of electrostatic discharges and provided information about how to eliminate them.

At this point, review the objectives listed at the beginning of the chapter to be certain that you understand the information associated with each one and that you can perform each item listed there. Afterward, answer the Review Questions that follow to verify your knowledge of the information.

KEY TERMS

- Ampere-hour rating
- Antistatic bags
- Antistatic foam
- Antistatic mats
- Antistatic solution
- Antivirus program
- Brownouts
- Chassis ground
- Class-C fire extinguisher
- Complementary-symmetry metal oxide semiconductor (CMOS)
- Earth ground
- Electromagnetic interference (EMI)
- Electrostatic discharges (ESD)
- Ground
- Grounding strap
- Hazardous substances
- Head-cleaning disks
- Material Safety Data Sheets (MSDS)
- Mean time between failures (MTBF)
- Metal oxide semiconductor (MOS)
- Oxidation buildup

continued

- Power-line filters
- Preventive maintenance (PM)
- Protective ground
- Radio frequency interference (RFI)
- Recycling
- Screen saver program
- Signal ground
- Spikes
- Standby power system
- Surge Suppressors
- Surges
- Temperature cycling
- Transients
- Uninterruptible Power Supply (UPS)
- Voltage sags
- Volt-ampere (VA) rating
- Wattage rating

URL Resources

www.halloa.com.tw/

http://suttondesigns.com/upssizing.htm#CLONES

www.powerprotector.com/scripts/gc_page.exe?F=F&K=protect

www.hei.com/heco/esafe.htm

http://kerr.arborlink.com/computers/disposal.html

http://kerr.arborlink.com/computers/recycle.html

www.borg.com/~eosesd/eos19.htm

www.netlabs.net/hp/echase/

APPLY YOUR KNOWLEDGE

At this point, review the objectives listed at the beginning of the chapter to be certain that you understand the information associated with each one and that you can perform each item listed there. Afterward, answer the Review and Exam Questions that follow to verify your knowledge of the information.

Review Questions

1. List the two most dangerous areas of a typical microcomputer system, and describe why they are so dangerous.
2. Name three devices used to minimize ESD in the repair area.
3. The best general-purpose cleaning tool for computer equipment is _____.
4. List at least three environmental conditions that can adversely affect microcomputer equipment.
5. A short undervoltage condition, lasting milliseconds, is called _____.
6. Are there any restrictions on disposing of a spent toner cartridge?
7. Which type of IC device is most likely to be damaged by ESD?
8. Can an effective ESD strap be constructed by just wrapping a grounded bare wire around your wrist?
9. What is the most effective way to deal with EMI problems?
10. The best way to protect computer equipment from a thunderstorm is to _____.
11. The best way to transport electronic devices is _____.
12. Will a surge suppresser prevent electrical damage from occurring to a system board?
13. List computer-related PM items that should be performed annually.
14. Name two characteristics that should be checked carefully before purchasing a UPS for a given computer system.
15. Describe the normal duration of a voltage spike.

Exam Questions

1. What is the most common cause of ESD in microcomputer systems?

   A. Moving people

   B. High humidity

   C. Rubber mats

   D. Grounded power-supply cables

2. Where would it be inappropriate to use an ESD wrist strap?

   A. While working on hard disk drives

   B. While working on system boards

   C. While working on CRT video monitors

   D. While working on printers

3. What is the best substance for cleaning the plastic surfaces of a computer system?

   A. A water and fabric softener solution

   B. A water and ammonia solution

   C. A water and bleach solution

   D. A hydrogen tetrachloride solution

APPLY YOUR KNOWLEDGE

4. The most effective grounding system for a microcomputer is _____.

   A. An ESD wrist or ankle strap

   B. The safety ground plug at a commercial AC receptacle

   C. The ground plane of the system board

   D. The chassis ground provided by brass standoffs

5. A short overvoltage occurrence (nanoseconds) is called _____.

   A. A spike

   B. A surge

   C. A brownout

   D. A sag

6. ESD is most likely to occur during periods of _____.

   A. Low humidity

   B. High humidity

   C. Medium humidity

   D. Rain

7. What is the best way to clean a keyboard?

   A. Spray with an antistatic solution

   B. Blow with compressed air

   C. Vacuum and clean with a damp cloth

   D. Wash with soap and water

8. What type of backup device is typically used to store large banks of information for an extended period of time?

   A. A floppy disk

   B. A tape drive

   C. A hard drive

   D. A CD-ROM drive

9. The best protection against power-failure data loss is _____.

   A. A tape backup

   B. A surge suppresser

   C. A UPS

   D. A line filter

10. Define a voltage sag.

    A. An overvoltage condition that lasts for a few milliseconds

    B. An undervoltage condition that lasts for an extended period

    C. An overvoltage condition that lasts for an extended period

    D. An undervoltage condition that lasts for a few milliseconds

Answers to Review Questions

1. The inside of the monitor and the inside of the power supply. Both units house potentially dangerous voltage levels inside their housings. For more information, see the section "Avoiding High-Voltage Hazards."

2. An antistatic wrist strap, rubber antistatic mats, and a humidifier. For more information, see the section "MOS-Handling Techniques."

3. A damp cloth is the best general-purpose cleaning tool. For more information, see the section "Cleaning."

APPLY YOUR KNOWLEDGE

4. Smoke, dust, temperatures above 85°F, and on/off cycles. For more information, see the section "Preventive Maintenance Procedures."
5. A sag. For more information, see the section "Power-Line Protection."
6. No, not currently. However, it is economical to recycle toner cartridges unless the output from the printer has to be of very high quality. For more information, see the section "Disposal Procedures."
7. MOS devices in general, and CMOS devices in particular, are most likely to be affected by ESD damage. For more information, see the section "MOS-Handling Techniques."
8. No. True ESD protection devices have resistive elements built in to them to protect the user (human) from shock hazards. For more information, see the section "MOS-Handling Techniques."
9. The best protection against EMI problems is good grounding. For more information, see the section "Understanding Grounds."
10. Unplug it and all of its peripherals from the power outlet so that there is no path for the lightening to follow. For more information, see the section "Understanding Grounds."
11. To place them in an antistatic bag. For more information, see the section "MOS-Handling Techniques."
12. A surge suppresser can protect an electrical device only from power damage up to a point. If the ratings of the suppresser are exceeded, the device it is guarding could be damaged. For more information, see the section "Power-Line Protection."
13. Reformat the hard drive, reinstall all the application software, check all floppy disks, clean the R/W heads in the floppy drive, and then perform the monthly and semi-annual activities outlined in this chapter. For more information, see the section "Annual Activities."
14. Ampere-hour rating and wattage rating. For more information, see the section "Uninterruptible Power Supplies."
15. Nanoseconds. For more information, see the section "Power-Line Protection."

Answers to Exam Questions

1. **A.** People moving around are the number-one source of ESD. Clothing rubbing against other materials or the body can create it, as can moving across certain types of carpet. ESD is more likely to happen in times of low humidity. Rubber mats and grounded conductors are the best way to prevent and safely remove ESD. For more information, see the section "Electrostatic Discharge."
2. **C.** Due to the dangerous voltage levels present inside the monitor, it is not a place to be wearing a conductive strap attached to your body. It may be dangerous to wear an antistatic strap in some areas of a printer. However, they are generally thought of as safe for such devices. For more information, see the section "MOS-Handling Techniques."
3. **A.** A water and fabric softener solution applied with a soft cloth is the best tool for cleaning the plastic surfaces of the system, as well as the monitor face. The antistatic properties of the fabric

APPLY YOUR KNOWLEDGE

softener removes static buildup from the surfaces in addition to removing dust and dirt. For more information, see the section "Cleaning."

4. **B.** The ground lead of a commercial three-prong power receptacle generally provides the best grounding source available, because it is tied to the true (earth) ground. The commercial power system provides a well-planned grounding system. For more information, see the section "Understanding Grounds."

5. **A.** A power surge lasts for periods ranging into the nanosecond range. Shorter overvoltage occurrences are called spikes. Brownouts and sags are undervoltage conditions. For more information, see the section "Power-Line Protection."

6. **A.** Low humidity raises the likelihood that ESD will occur. The other conditions decrease the likelihood of ESD. For more information, see the section "Electrostatic Discharge."

7. **C.** The keyboard can be vacuumed to remove dust and debris from inside the unit, and should be wiped with a damp cloth to clean the outside. Blowing dust out of the keyboard with low-power-compressed air bottles is acceptable, but liquids should never be used on electronic equipment except when applied with a cloth. For more information, see the section "Protecting Input Devices."

8. **B.** Tape drives are routinely used for storage due to their low-cost-per-bit storage capabilities and their nonvolatile nature. Although CD-Rs are gaining ground as storage devices, they are not yet widely used for this purpose. For more information, see the section "Protecting Hard Disk Drives."

9. **C.** The UPS is the best protection against losing data when power interruptions occur. Surge suppressors and line filters can protect against small power variations, but cannot handle sustained power-line problems. Tape drives offer the best protection for data that has been backed up to a storage media, but cannot protect data that has been entered since the last backup. For more information, see the section "Power-Line Protection."

10. **D.** A voltage sag is an undervoltage condition that lasts for a few milliseconds. Sags that last for a sustained period of time are referred to as brownouts. For more information, see the section "Power-Line Protection."