IT Essentials

PC Hardware and Software Companion Guide

Fifth Edition

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IT Essentials:

PC Hardware and Software Companion Guide

Fifth Edition

Cisco Networking Academy

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IT Essentials: PC Hardware and Software Companion Guide, Fifth Edition

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Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Europe Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: +31 0 800 020 0791
Fax: +31 0 20 357 1100

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About the Contributing Authors

Kathleen Czurda-Page is the lead instructor for the Cisco Networking Academy at North Idaho College. She teaches IT Essentials and CCNA courses, along with introduction to computers in business courses and business leadership. Kathleen has a degree in Computer Applications in Business from North Idaho College. She earned her bachelor's degree in professional technical education, her master's degree in adult and organizational learning, and education specialist degree in adult/organizational learning and leadership at the University of Idaho. She also holds Cisco and CompTIA certifications. Kathleen lives with her lovely family in Coeur d'Alene, Idaho.

Laura Kier is the Cisco Networking Academy Lead at Spokane Community College in Spokane, Washington. She teaches CCNA Exploration, ITE, and CCNA Security, in addition to business software computer courses. Laura has a BS from Oregon State University and a certificate in Computer Forensics and Network Security from Spokane Falls Community College. She is a Certified Cisco Academy Instructor and has her CCNA, A+, and Net+ certificates. She and her husband live in Spokane, Washington.

Contents At a Glance

Contents

Introduction

IT Essentials: PC Hardware and Software Companion Guide, Fifth Edition, is a supplemental book to the Cisco Networking Academy IT Essentials: PC Hardware and Software Version 5 course. The course teaches you how to build a computer and troubleshoot problems that occur in everyday use. The course is designed to prepare you to take and pass the CompTIA A+ exams (based on the 2012 objectives). By reading and completing this book, you have the opportunity to review all key concepts that the CompTIA A+ exams cover. If you use this book along with its companion, *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition (ISBN 1-58713-310-5), you can reinforce those concepts with hands-on exercises and test that knowledge with review questions and exercises.

The IT Essentials: PC Hardware and Software course aligns with the CompTIA A+ (220-801) exam and CompTIA A+ (220-802) exam. You must pass both exams to earn the CompTIA A+ certification.

Who Should Read This Book

This book is intended for students in the Cisco Networking Academy IT Essentials: PC Hardware and Software Version 5 course. This student is usually pursuing a career in information technology (IT) or wants to have the knowledge of how a computer works, how to assemble a computer, and how to troubleshoot hardware and software issues.

Book Features

The features in this book facilitate an understanding of computer systems and troubleshooting system problems. The highlights of each chapter are as follows:

- **Objectives:** Each chapter starts with a list of objectives that should be mastered by the end of the chapter. The objectives are framed as focus questions addressing the concepts covered in the chapter.
- **Key terms:** Each chapter includes a list of the key terms identified in the chapter, listed in the order in which they appear in the chapter. These terms serve as a study aid and are defined in the book's Glossary. The key terms reinforce the concepts introduced in the chapter and help you understand the chapter material before you move on to new concepts. You can find the key terms highlighted in blue throughout the chapter, in the context in which they are most important.

- **Explanatory text, lists, figures, and tables:** This book contains figures, procedures, and tables to accompany the thorough text explanations of the objective content and to help explain and visualize theories, concepts, commands, and setup sequences.
- **Chapter summaries:** At the end of each chapter is a summary of the concepts covered in the chapter. The summary provides a synopsis of the chapter and serves as a study aid.
- **Lab, worksheet, and class discussion references:** There are references to the labs, worksheets, and class discussion exercises that can be found in the accompanying *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition (ISBN 1-58713-310-5).
- **Virtual Desktop activity and Virtual Laptop activity references:** Designed and developed by the Cisco Networking Academy, these activities are virtual learning tools to help you develop critical thinking and complex problem-solving skills. How to access these activities is discussed in the following section, "Accessing Packet Tracer, Virtual Laptop, and Virtual Desktop Activities."
- **Packet Tracer activities:** Cisco Packet Tracer simulation-based learning activity files promote the exploration of networking and network security concepts and enable you to experiment with network behavior. How to access these activities is discussed in the following section, "Accessing Packet Tracer, Virtual Laptop, and Virtual Desktop Activities."
- **"Check Your Understanding" review questions:** Review questions are presented at the end of each chapter to serve as an assessment. In addition, the questions reinforce the concepts introduced in the chapter and help test your understanding before you move on to subsequent chapters. Answers to the questions are available in the Appendix.

Accessing Packet Tracer, Virtual Laptop, and Virtual Desktop Activities

All the Packet Tracer activities, Virtual Laptop, and Virtual Desktop activities are available within your IT Essentials Version 5 course in Netspace. However, you can also get easy access just to these activities if you register this Companion Guide on the Cisco Press website. Please visit **http://**ciscopress.com/register, create an account, and register your book. Once you have an account and have registered your book, follow the Access Bonus Content link to view the downloadable activities.

Note that you need to have the Packet Tracer software to use these Packet Tracer activity files. Packet Tracer is available only through the Cisco Networking Academy. Ask your instructor for a copy of this software. Also note that the most current files will always be found within the course on Netspace. Access to these files on the Cisco Press site is intended only for convenience of access for those of you using the Companion Guide textbook accompanying your course.

How This Book Is Organized

This book corresponds closely to the Cisco IT Essentials course and is divided into 12 chapters, one appendix, and a glossary of key terms:

- **Chapter 1, "Introduction to the Personal Computer"**: Information technology (IT) is the design, development, implementation, support, and management of computer hardware and software applications. A computer is an electronic machine that performs calculations based on a set of instructions. A computer system consists of hardware and software components. This chapter discusses hardware components found in a computer system, selecting replacement computer components, and configurations for specialized computer systems.
- **Chapter 2, "Lab Procedures and Tool Use"**: This chapter covers basic safety practices for the workplace, hardware and software tools, and the disposal of hazardous materials. Safety guidelines help protect individuals from accidents and injury and protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination by discarded materials. You will also learn how to protect equipment and data and how to properly use hand and software tools.
- **Chapter 3, "Computer Assembly"**: Assembling computers is a large part of a technician's job. As a technician, you must work in a logical, methodical manner when working with computer components. At times, you might have to determine whether a component for a customer's computer needs to be upgraded or replaced. It is important that you develop advanced skills in installation procedures, troubleshooting techniques, and diagnostic methods. This chapter discusses the importance of component compatibility across hardware and software.
- **Chapter 4, "Overview of Preventive Maintenance"**: Troubleshooting is the systematic process used to locate the cause of a fault in a computer system and correct the relevant hardware and software issues. In this chapter, you will learn general guidelines for creating preventive maintenance programs and troubleshooting procedures. These guidelines are a starting point to help you develop your preventive maintenance and troubleshooting skills.

- **Chapter 5, "Operating Systems"**: The operating system (OS) controls almost all functions on a computer. In this chapter, you learn about the components, functions, and terminology related to the Windows 2000, Windows XP, Windows Vista, and Windows 7 operating systems.
- **Chapter 6, "Networks"**: This chapter provides an overview of network principles, standards, and purposes. The different types of network topologies, protocols, and logical models, in addition to the hardware needed to create a network, are also discussed in this chapter. Configuration, troubleshooting, and preventive maintenance are covered. You also learn about network software, communication methods, and hardware relationships.
- **Chapter 7, "Laptops"**: With the increase in demand for mobility, the popularity of mobile devices will continue to grow. During the course of your career, you will be expected to know how to configure, repair, and maintain these devices. The knowledge you acquire about desktop computers will help you service laptops and portable devices. However, there are important differences between the two technologies. This chapter examines these differences and how to techniques to use specific to laptops.
- **Chapter 8, "Mobile Devices"**: A mobile device is any device that is handheld, is light, and typically uses a touchscreen for input. Like a desktop or laptop computer, mobile devices use an operating system to run applications (apps) and games and play movies and music. It is important to become familiar with as many different mobile devices as possible. You may be required to know how to configure, maintain, and repair various mobile devices. Mastering the skills necessary to work on mobile devices is important to your career advancement. This chapter focuses on the many features of mobile devices and their capabilities, including configuration, synchronization, and data backup.
- **Chapter 9, "Printers"**: This chapter provides essential information about printers. You will learn how printers operate, what to consider when purchasing a printer, and how to connect printers to an individual computer or to a network.
- **Chapter 10, "Security"**: Technicians need to understand computer and network security. Failure to implement proper security procedures can have an impact on users, computers, and the general public. Private information, company secrets, financial data, computer equipment, and items of national security are placed at risk if proper security procedures are not followed. This chapter covers why security is important, security threats, security procedures, how to troubleshoot security issues, and how you can work with customers to ensure that the best possible protection is in place.

- **Chapter 11, "The IT Professional"**: As a computer technician, you not only fix computers, but also interact with people. In fact, troubleshooting is as much about communicating with the customer as it is about knowing how to fix a computer. In this chapter, you learn to use good communication skills as confidently as you use a screwdriver.
- **Chapter 12, "Advanced Troubleshooting"**: In your career as a technician, it is important that you develop advanced skills in troubleshooting techniques and diagnostic methods for computer components, operating systems, networks, laptops, printers, and security issues. Advanced troubleshooting can sometimes mean that the problem is unique or that the solution is difficult to perform. In this chapter, you will learn how to apply a troubleshooting process to solve computer problems.
- **Appendix A, "Answers to 'Check Your Understanding' Questions"**: This appendix lists the answers to the "Check Your Understanding" review questions that are included at the end of each chapter.
- **Glossary**: The Glossary provides you with definitions for all the key terms identified in each chapter.

About the CompTIA A+ Certification

As a CompTIA Authorized Quality Curriculum, IT Essentials: PC Hardware and Software v5 will help prepare you for the new CompTIA A+ Essentials and Practical Applications certification exams. To become A+ certified, you need to pass two exams to become certified in your chosen career area:

- CompTIA A+ (220-801)
- CompTIA A+ (220-802)

After becoming certified, you will be qualified to work as a computer support professional and technician in a variety of work environments and industries.

The CompTIA A+ exam is explained in detail, including a list of the objectives, at the following website:

http://www.comptia.org/certifications/listed/a.aspx

When you are ready to take the exam, you must purchase and schedule your two CompTIA A+ exams. You can find the necessary information to accomplish this at the following website:

http://certification.comptia.org/getCertified/certifications/a.aspx

Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a show command).
- *Italic* indicates arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets ([ ]) indicate an optional element.
- Braces ({ }) indicate a required choice.
- Braces within brackets ([{ }]) indicate a required choice within an optional element.

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CHAPTER 2

Lab Procedures and Tool Use

Objectives

Upon completion of this chapter, you will be able to answer the following questions:

- What are safe working conditions and procedures?
- What procedures help protect equipment and data?
- What procedures help to properly dispose of hazardous computer components and related material?
- What tools and software are used with personal computer components, and what is their purpose?
- What is proper tool use?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

electrostatic discharge (ESD) *page 79*

antistatic wrist strap *page 80*

electromagnetic interference (EMI) *page 80*

radio frequency interference (RFI) *page 80*

current *page 80*

power fluctuation *page 80*

blackout *page 80*

brownout *page 81*

noise *page 81*

spike *page 81*

power surge *page 81*

power protection device *page 81*

surge suppressor *page 81*

uninterruptible power supply *page 81*

standby power supply (SPS) *page 81*

Material Safety and Data Sheet (MSDS) *page 82*

Occupational Safety and Health Administration (OSHA) *page 82*

Registration, Evaluation, Authorization and restriction of Chemicals (REACH) *page 83*

antistatic mat *page 85*

hand tools *page 85*

flat-head screwdriver *page 85*

Phillips-head screwdriver *page 85*

hex driver *page 86*

Torx screwdriver *page 86*

part retriever *page 86*

wire stripper *page 86*

crimper *page 86*

punch-down tool *page 86*

Introduction (2.0.1)

This chapter covers basic safety practices for the workplace, hardware and software tools, and the disposal of hazardous materials. Safety guidelines help protect individuals from accidents and injury. They also help to protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination caused by improperly discarded materials. You will also learn how to protect equipment and data and how to properly use hand and software tools.

Safe Lab Procedures (2.1)

This section discusses safety in the lab. Safety guidelines help protect individuals from accidents and injury. They also help to protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination caused by improperly discarded materials.

General Safety (2.1.1.1)

Safe working conditions help prevent injury to people and damage to computer equipment. A safe workspace is clean, organized, and properly lighted. Everyone must understand and follow safety procedures.

Follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. As a best practice, make sure that a fire extinguisher and first-aid kit are available in case of fire or injury. Poorly placed or unsecured cables can cause tripping hazards in a network installation. Cables should be installed in conduit or cable trays to prevent hazards.

This is a partial list of basic safety precautions to use when working on a computer:

- Remove your watch and jewelry and secure loose clothing.
- Turn off the power and unplug equipment before performing service.
- Cover sharp edges inside the computer case with tape.
- Never open a power supply or a CRT monitor.
- Do not touch areas in printers that are hot or that use high voltage.
- Know where the fire extinguisher is located and how to use it.
- Keep food and drinks out of your workspace.
- Keep your workspace clean and free of clutter.
- Bend your knees when lifting heavy objects to avoid injuring your back.

Electrical Safety (2.1.1.2)

Follow electrical safety guidelines to prevent electrical fires, injuries, and fatalities in the home and the workplace. Power supplies and CRT monitors contain high voltage.

Caution

Only experienced technicians should attempt to repair power supplies and CRT monitors. Do not wear the antistatic wrist strap when repairing power supplies or CRT monitors.

Some printer parts become hot during use, and other parts might contain high voltage. Check the printer manual for the location of high-voltage components. Some components retain a high voltage even after the printer is turned off. Make sure that the printer has had time to cool before making the repair.

Electrical devices have certain power requirements. For example, AC adapters are manufactured for specific laptops. Exchanging power cords with a different type of laptop or device may cause damage to both the AC adapter and the laptop.

Fire Safety (2.1.1.3)

Follow fire safety guidelines to protect lives, structures, and equipment. To avoid an electrical shock and to prevent damage to the computer, turn off and unplug the computer before beginning a repair.

Fire can spread rapidly and be very costly. Proper use of a fire extinguisher can prevent a small fire from getting out of control. When working with computer components, be aware of the possibility of an accidental fire and know how to react. Be alert for odors emitting from computers and electronic devices. When electronic components overheat or short out, they emit a burning odor. If there is a fire, follow these safety procedures:

- Never fight a fire that is out of control or not contained.
- Always have a planned fire escape route before beginning any work.
- Get out of the building quickly.
- Contact emergency services for help.
- Locate and read the instructions on the fire extinguishers in your workplace before you have to use them.

Be familiar with the types of fire extinguishers used in your country or region. Each type of fire extinguisher has specific chemicals to fight different types of fires:

- Paper, wood, plastics, cardboard
- Gasoline, kerosene, organic solvents

- Electrical equipment
- Combustible metals

It is important to know how to use a fire extinguisher. Use the memory aid P-A-S-S to remember the basic rules of fire extinguisher operation:

- **P:** Pull the pin.
- **A:** Aim at the base of the fire, not at the flames.
- **S:** Squeeze the lever.
- **S:** Sweep the nozzle from side to side.

Procedures to Protect Equipment and Data (2.1.2)

Replacing equipment and recovering data is expensive and time consuming. This section identifies potential threats to systems and describes procedures to help prevent loss and damage.

ESD and EMI (2.1.2.1)

Electrostatic discharge (ESD), harsh climates, and poor-quality sources of electricity can cause damage to computer equipment. Follow proper handling guidelines, be aware of environmental issues, and use equipment that stabilizes power to prevent equipment damage and data loss.

Static electricity is the buildup of an electric charge resting on a surface. *Electrostatic discharge (ESD)* occurs when this buildup jumps to a component and causes damage. ESD can be destructive to the electronics in a computer system.

At least 3000 volts of static electricity must build up before a person can feel ESD. For example, static electricity can build up on you as you walk across a carpeted floor. When you touch another person, you both receive a shock. If the discharge causes pain or makes a noise, the charge was probably above 10,000 volts. By comparison, less than 30 volts of static electricity can damage a computer component.

ESD can cause permanent damage to electrical components. Follow these recommendations to help prevent ESD damage:

- Keep all components in antistatic bags until you are ready to install them.
- Use grounded mats on workbenches.

- Use grounded floor mats in work areas.
- Use *antistatic wrist straps* when working on computers.

Electromagnetic interference (EMI) is the intrusion of outside electromagnetic signals in a transmission media, such as copper cabling. In a network environment, EMI distorts the signals so that the receiving devices have difficulty interpreting them.

EMI does not always come from expected sources, such as cellular phones. Other types of electric equipment can emit a silent, invisible electromagnetic field that can extend for more than a mile (1.6 km).

There are many sources of EMI:

- Any source designed to generate electromagnetic energy
- Manmade sources like power lines or motors
- Natural events such as electrical storms, or solar and interstellar radiations

Wireless networks are affected by *radio frequency interference (RFI)*. RFI is caused by radio transmitters and other devices transmitting in the same frequency. For example, a cordless telephone can cause problems with a wireless network when both devices use the same frequency. Microwaves can also cause interference when positioned in close proximity to wireless networking devices.

Climate

Climate affects computer equipment in a variety of ways:

- If the environment temperature is too high, equipment can overheat.
- If the humidity level is too low, the chance of ESD increases.
- If the humidity level is too high, equipment can suffer from moisture damage.

Power Fluctuation Types (2.1.2.2)

Voltage is the force that moves electrons through a circuit. The movement of electrons is called *current*. Computer circuits need voltage and current to operate electronic components. When the voltage in a computer is not accurate or steady, computer components might not operate correctly. Unsteady voltages are called *power fluctuations*.

The following types of AC power fluctuations can cause data loss or hardware failure:

- *Blackout*: Complete loss of AC power. A blown fuse, damaged transformer, or downed power line can cause a blackout.

- *Brownout*: Reduced voltage level of AC power that lasts for a period of time. Brownouts occur when the power line voltage drops below 80 percent of the normal voltage level. Overloading electrical circuits can cause a brownout.
- *Noise*: Interference from generators and lightning. Noise results in poor quality power, which can cause errors in a computer system.
- *Spike*: Sudden increase in voltage that lasts for a short period and exceeds 100 percent of the normal voltage on a line. Spikes can be caused by lightning strikes but can also occur when the electrical system comes back on after a blackout.
- *Power surge*: Dramatic increase in voltage above the normal flow of electrical current. A power surge lasts for a few nanoseconds, or one-billionth of a second.

Power Protection Devices (2.1.2.3)

To help shield against power fluctuation problems, use *power protection devices* to protect the data and computer equipment:

- *Surge suppressor*: Helps protect against damage from surges and spikes. A surge suppressor diverts extra electrical voltage that is on the line to the ground.
- *Uninterruptible power supply (UPS)*: Helps protect against potential electrical power problems by supplying a consistent level of electrical power to a computer or other device. The battery is constantly recharging while the UPS is in use. The UPS provides a consistent quality of power when brownouts and blackouts occur. Many UPS devices can communicate directly with the computer operating system. This communication allows the UPS to safely shut down the computer and save data prior to the UPS losing all electrical power.
- *Standby power supply (SPS)*: Helps protect against potential electrical power problems by providing a backup battery to supply power when the incoming voltage drops below the normal level. The battery is on standby during normal operation. When the voltage decreases, the battery provides DC power to a power inverter, which converts it to AC power for the computer. This device is not as reliable as a UPS because of the time it takes to switch over to the battery. If the switching device fails, the battery cannot supply power to the computer.

Caution

UPS manufacturers suggest never plugging in a laser printer to a UPS because the printer could overload the UPS.

Procedures to Protect the Environment (2.1.3)

Most computers and peripherals use and contain at least some materials that can be considered toxic to the environment. This section describes tools and procedures that help identify these materials and the steps for the proper handling and disposal of the materials.

Material Safety and Data Sheet (2.1.3.1)

Computers and peripherals contain materials that can be harmful to the environment. Hazardous materials are sometimes called toxic waste. These materials can contain high concentrations of heavy metals such as cadmium, lead, or mercury. The regulations for the disposal of hazardous materials vary by state or country. Contact the local recycling or waste removal authorities in your community for information about disposal procedures and services.

A *Material Safety and Data Sheet (MSDS)* is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first-aid requirements. The MSDS contains chemical reactivity and incompatibility information. It also includes protective measures for the safe handling and storage of materials and spill, leak, and disposal procedures.

To determine whether a material is classified as hazardous, consult the manufacturer's MSDS. In the United States, the *Occupational Safety and Health Administration (OSHA)* requires that all hazardous materials be accompanied by an MSDS when transferred to a new owner. The MSDS information included with products purchased for computer repairs or maintenance can be relevant to computer technicians. OSHA also requires that employees be informed about the materials that they are working with and be provided with material safety information. Figure 2-1 shows the OSHA website where you can find the MSDS form and more information.

Figure 2-1 MSDS

Note

The MSDS is valuable in determining how to dispose of potentially hazardous materials in the safest manner. Always check local regulations concerning acceptable disposal methods before disposing of any electronic equipment.

The MSDS contains valuable information:

- Name of the material
- Physical properties of the material
- Hazardous ingredients contained in the material
- Reactivity data, such as fire and explosion data
- Procedures for spills and leaks
- Special precautions
- Health hazards
- Special protection requirements

In the European Union, the regulation *Registration, Evaluation, Authorization and restriction of Chemicals (REACH)* came into effect on June 1, 2007, replacing various directives and regulations with a single system.

Equipment Disposal (2.1.3.2)

The proper disposal or recycling of hazardous computer components is a global issue. Make sure to follow regulations that govern how to dispose of specific items. Organizations that violate these regulations can be fined or face expensive legal battles.

Batteries

Batteries often contain rare earth metals that can be harmful to the environment. Batteries from portable computer systems can contain lead, cadmium, lithium, alkaline manganese, and mercury. These metals do not decay and remain in the environment for many years. Mercury is commonly used in the manufacturing of batteries and is extremely toxic and harmful to humans.

Recycling batteries should be a standard practice for a technician. All batteries, including lithium-ion, nickel-cadmium, nickel-metal hydride, and lead-acid, are subject to disposal procedures that comply with local environmental regulations.

Monitors

Monitors contain glass, metal, plastics, lead, barium, and rare earth metals. According to the U.S. Environmental Protection Agency (EPA), monitors can contain approximately 4 pounds (1.8 kg) of lead. Monitors must be disposed of in compliance with environmental regulations.

Handle CRT monitors with care. Extremely high voltage can be stored in CRT monitors, even after being disconnected from a power source.

Toner Kits, Cartridges, and Developers

Used printer toner kits and printer cartridges must be disposed of properly or recycled. Some toner cartridge suppliers and manufacturers take empty cartridges for refilling. Some companies specialize in refilling empty cartridges. Kits to refill inkjet printer cartridges are available but are not recommended because the ink might leak into the printer, causing irreparable damage. Using refilled inkjet cartridges might also void the inkjet printer warranty.

Chemical Solvents and Aerosol Cans

Contact the local sanitation company to learn how and where to dispose of the chemicals and solvents used to clean computers. Never dump chemicals or solvents down a sink or dispose of them in a drain that connects to public sewers.

The cans or bottles that contain solvents and other cleaning supplies must be handled carefully. Make sure that they are identified and treated as special hazardous waste. For example, some aerosol cans explode when exposed to heat if the contents are not completely used.

Proper Use of Tools (2.2)

Using tools properly helps prevent accidents and damage to equipment and people. This section describes and covers the proper use of a variety of hardware, software, and organizational tools specific to working with computers and peripherals.

Hardware Tools (2.2.1)

For every job there is the right tool. Make sure that you are familiar with the correct use of each tool and that the correct tool is used for the current task. Skilled use of tools and software makes the job less difficult and ensures that tasks are performed properly and safely.

A toolkit should contain all the tools necessary to complete hardware repairs. As you gain experience, you learn which tools to have available for different types of jobs. Hardware tools are grouped into four categories:

- ESD tools
- Hand tools
- Cleaning tools
- Diagnostic tools

Figure 2-2 shows some common tools used in computer repair.

Figure 2-2 Computer Tools

ESD Tools (2.2.1.2)

There are two ESD tools: the antistatic wrist strap and the *antistatic mat*. The antistatic wrist strap protects computer equipment when grounded to a computer chassis. The antistatic mat protects computer equipment by preventing static electricity from accumulating on the hardware or on the technician.

Hand Tools (2.2.1.3)

Most tools used in the computer assembly process are small *hand tools*. They are available individually or as part of a computer repair toolkit. Toolkits range widely in size, quality, and price. Some common hand tools and their uses are

- *Flat-head screwdriver*: Used to tighten or loosen slotted screws.
- *Phillips-head screwdriver*: Used to tighten or loosen cross-headed screws.

- *Torx screwdriver*: Used to tighten or loosen screws that have a star-like depression on the top, a feature that is mainly found on laptops.
- *Hex driver*: Used to tighten or loosen nuts in the same way that a screwdriver tightens or loosens screws (sometimes called a nut driver).
- **Needle-nose pliers:** Used to hold small parts.
- **Wire cutters:** Used to strip and cut wires.
- **Tweezers:** Used to manipulate small parts.
- *Part retriever*: Used to retrieve parts from locations that are too small for your hand to fit.
- **Flashlight:** Used to light up areas that you cannot see well.
- *Wire stripper*: A wire stripper is used to remove the insulation from wire so that it can be twisted to other wires or crimped to connectors to make a cable.
- *Crimper*: Used to attach connectors to wires.
- *Punch-down tool*: Used to terminate wire into termination blocks. Some cable connectors must be connected to cables using a punch down tool.

Cleaning Tools (2.2.1.4)

Having the appropriate *cleaning tools* is essential when maintaining and repairing computers. Using the appropriate cleaning tools helps ensure that computer components are not damaged during cleaning. Cleaning tools include the following:

- **Soft cloth:** Used to clean different computer components without scratching or leaving debris
- **Compressed air:** Used to blow away dust and debris from different computer parts without touching the components
- **Cable ties:** Used to bundle cables neatly inside and outside of a computer
- **Parts organizer:** Used to hold screws, jumpers, fasteners, and other small parts and prevents them from getting mixed together

Diagnostic Tools (2.2.1.5)

Diagnostic tools are used to test and diagnose equipment. Diagnostic tools include the following:

- A *digital multimeter*, as shown in Figure 2-3, is a device that can take many types of measurements. It tests the integrity of circuits and the quality of electricity in computer components. A digital multimeter displays the information on an LCD or LED.

Figure 2-3 Multimeter

- A *loopback adapter*, also called a loopback plug, tests the basic functionality of computer ports. The adapter is specific to the port that you want to test.
- The *toner probe*, as shown in Figure 2-4, is a two-part tool. The toner part is connected to a cable at one end using specific adapters, such as an RJ-45, coaxial, or metal clips. The toner generates a tone that travels the length of the cable. The probe part traces the cable. When the probe is in near proximity to the cable to which the toner is attached, the tone can be heard through a speaker in the probe.

Figure 2-4 Toner Probe

Although an *external hard drive enclosure* is not a diagnostic tool, it is often used when diagnosing and repairing computers. The customer hard drive is placed into the external enclosure for inspection, diagnosis, and repair using a known-working computer. Backups can also be recorded to a drive in an external enclosure to prevent data corruption during a computer repair.

Software Tools (2.2.2)

Like hardware tools, there are a variety of software tools that can be used to help technicians pinpoint and troubleshoot problems. Many of these tools are free and several come with the Windows operating system.

Disk Management Tools (2.2.2.1)

Software tools help diagnose computer and network problems and determine which computer device is not functioning correctly. A technician must be able to use a range of software tools to diagnose problems, maintain hardware, and protect the data stored on a computer.

You must be able to identify which software to use in different situations. *Disk management tools* help detect and correct disk errors, prepare a disk for data storage, and remove unwanted files.

The following are some disk management tools:

- **FDISK:** A command-line tool that creates and deletes partitions on a hard drive. The FDISK tool is not available in Windows XP, Vista, or 7. It has been replaced with the Disk Management tool.
- **Disk Management Tool:** Initializes disks, creates partitions, and formats partitions.
- *Format*: Prepares a hard drive to store information.
- *ScanDisk or CHKDSK*: Checks the integrity of files and folders on a hard drive by scanning the file system. These tools might also check the disk surface for physical errors.
- *Defrag*: Optimizes space on a hard drive to allow faster access to programs and data.
- *Disk Cleanup*: Clears space on a hard drive by searching for files that can be safely deleted.
- *System File Checker (SFC)*: A command-line tool that scans the operating system critical files and replaces files that are corrupted.

Use the Windows 7 boot disk for troubleshooting and repairing corrupted files. The Windows 7 boot disk repairs Windows system files, restores damaged or lost files, and reinstalls the operating system.

Third-party software tools are also available to assist in troubleshooting problems.

Protection Software Tools (2.2.2.2)

Each year, viruses, spyware, and other types of malicious attacks infect millions of computers. These attacks can damage operating systems, applications, and data. Computers that have been infected may even have problems with hardware performance or component failure.

To protect data and the integrity of the operating system and hardware, use software designed to guard against attacks and to remove malicious programs.

Various types of software protect hardware and data:

- *Windows 7 Action Center*: Checks the status of essential security settings. The Action Center continuously checks to make sure that the software firewall and antivirus programs are running. It also ensures that automatic updates download and install automatically.
- **Antivirus program:** Protects against virus attacks.
- *Antispyware program*: Protects against software that sends information about web surfing habits to an attacker. Spyware can be installed without the knowledge or consent of the user.
- *Windows 7 Firewall*: Runs continuously to protect against unauthorized communications to and from your computer.

Worksheet 2.2.2.3: Diagnostic Software

In this worksheet, you use the Internet, a newspaper, or a local store to gather information about a hard drive diagnostic program. Be prepared to discuss the diagnostic software you researched. Refer to the worksheet in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Organizational Tools (2.2.3)

Keeping accurate records and journals during a busy workday can be challenging. Many organizational tools, such as work-order systems, can help the technician document their work.

Reference Tools (2.2.3.1)

A technician must document all repairs and computer problems. The documentation can then be used as a reference for future problems or for other technicians who may not have encountered the problem before. The documents can be paper based, but electronic forms are preferred because they can be easily searched for specific problems.

It is important that a technician document all services and repairs. These documents need to be stored centrally and made available to all other technicians. The documentation can then be used as reference material for similar problems that are encountered in the future. Good customer service includes providing the customer with a detailed description of the problem and the solution.

Personal Reference Tools

Personal reference tools include troubleshooting guides, manufacturer manuals, quick reference guides, and repair journals. In addition to an invoice, a technician keeps a journal of upgrades and repairs. The documentation in the journal includes descriptions of the problem, possible solutions that have been attempted, and the steps taken to repair the problem. Note any configuration changes made to the equipment and any replacement parts used in the repair. This documentation is valuable when you encounter similar situations in the future.

- **Notes:** Make notes as you go through the troubleshooting and repair process. Refer to these notes to avoid repeating previous steps and to determine what steps to take next.
- **Journal:** Document the upgrades and repairs that you perform. Include descriptions of the problem, possible solutions that have been tried to correct the problem, and the steps taken to repair the problem. Note any configuration changes made to the equipment and any replacement parts used in the repair. Your journal, along with your notes, can be valuable when you encounter similar situations in the future.
- **History of repairs:** Make a detailed list of problems and repairs, including the date, replacement parts, and customer information. The history allows a technician to determine what work has been performed on a specific computer in the past.

Internet Reference Tools

The Internet is an excellent source of information about specific hardware problems and possible solutions:

- Internet search engines
- News groups
- Manufacturer FAQs
- Online computer manuals
- Online forums and chat
- Technical websites

Miscellaneous Tools (2.2.3.2)

With experience, you will discover many additional items to add to the toolkit. Figure 2-5 shows how a roll of masking tape can be used to label parts that have been removed from a computer when a parts organizer is not available.

Figure 2-5 Parts Labels

A working computer is also a valuable resource to take with you on computer repairs in the field. A working computer can be used to research information, download tools or drivers, and communicate with other technicians.

Figure 2-6 shows the types of computer replacement parts to include in a toolkit. Make sure that the parts are in good working order before you use them. Using known good components to replace possible bad ones in computers helps you quickly determine which component is not working properly.

Figure 2-6 Replacement Computer Parts

Demonstrate Proper Tool Use (2.2.4)

This section describes the proper use of common tools used to protect, repair, and clean computers and peripherals.

Antistatic Wrist Strap (2.2.4.1)

Safety in the workplace is everyone's responsibility. You are much less likely to injure yourself or damage components when using the proper tool for the job.

Before cleaning or repairing equipment, make sure that your tools are in good condition. Clean, repair, or replace items that are not functioning adequately.

An example of ESD is the small shock that you receive when you walk across a carpeted room and touch a doorknob. Although the small shock is harmless to you, the same electrical charge passing from you to a computer can damage its components. Self-grounding or wearing an antistatic wrist strap can prevent ESD damage to computer components.

The purpose of self-grounding or wearing an antistatic wrist strap is to equalize the electrical charge between you and the equipment. Self-grounding is done by touching a bare metal part of a computer case. The antistatic wrist strap is a conductor that connects your body to the equipment that you are working on. When static electricity builds up in your body, the connection made by the wrist strap to the equipment, or ground, channels the electricity through the wire that connects the strap.

As shown in Figure 2-7, the wrist strap has two parts and is easy to wear. Following is the proper procedure for using an antistatic wrist strap:

How To

Step 1. Wrap the strap around your wrist and secure it using the snap or Velcro. The metal on the back of the wrist strap must remain in contact with your skin at all times.

Step 2. Snap the connector on the end of the wire to the wrist strap, and connect the other end either to the equipment or to the same grounding point that the antistatic mat is connected to. The metal skeleton of the case is a good place to connect the wire. When connecting the wire to equipment that you are working on, choose an unpainted metal surface. A painted surface does not conduct electricity as well as unpainted metal.

Figure 2-7 Antistatic Wrist Strap

Note

Attach the wire on the same side of the equipment as the arm wearing the antistatic wrist strap. This helps keep the wire out of the way while you are working.

Although wearing a wrist strap helps prevent ESD, you can further reduce the risks by not wearing clothing made of silk, polyester, or wool. These fabrics are more likely to generate a static charge.

Note

Technicians should roll up their sleeves, remove scarves or ties, and tuck in shirts to prevent interference from clothing. Ensure that earrings, necklaces, and other loose jewelry are properly secured.

Caution

Never wear an antistatic wrist strap if you are repairing a CRT monitor or a power supply unit.

Antistatic Mat (2.2.4.2)

You might not always have the option to work on a computer in a properly equipped workspace. If you can control the environment, try to set up your workspace away from carpeted areas. Carpets can cause the buildup of electrostatic charges. If you cannot avoid the carpeting, ground yourself to the unpainted portion of the case of the computer on which you are working before touching any components.

An antistatic mat is slightly conductive. It works by drawing static electricity away from a component and transferring it safely from equipment to a grounding point, as shown in Figure 2-8. Following is the proper procedure for using an antistatic mat:

How To

Step 1. Lay the mat on the workspace next to or under the computer case.

Step 2. Clip the mat to the case to provide a grounded surface on which you can place parts as you remove them from the system.

Figure 2-8 Antistatic Mat

When you are working at a workbench, ground the workbench and the antistatic floor mat. By standing on the mat and wearing the wrist strap, your body has the same charge as the equipment and reduces the probability of ESD. Either connect the table-top mat and the floor mat to each other or connect both to the electrical earth ground.

Reducing the potential for ESD reduces the likelihood of damage to delicate circuits or components.

Note

Always handle components by the edges.

Hand Tools (2.2.4.3)

A technician needs to be able to properly use each tool in the toolkit. This topic covers many of the various hand tools used when repairing computers.

Screws

Match each screw with the proper screwdriver. Place the tip of the screwdriver on the head of the screw. Turn the screwdriver clockwise to tighten the screw and counterclockwise to loosen the screw.

Screws can become stripped if you over-tighten them with a screwdriver. A stripped screw, as shown in Figure 2-9, may get stuck in the screw hole, or it may not tighten firmly. Discard stripped screws.

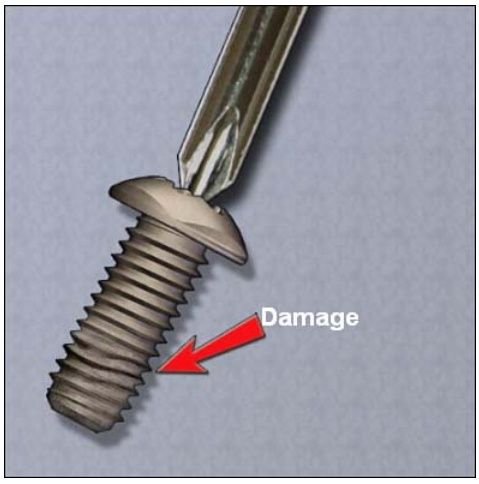

Figure 2-9 Stripped Screw

Flat-Head Screwdriver

Use a flat-head screwdriver when you are working with a slotted screw. Do not use a flat-head screwdriver to remove a Phillips-head screw. Never use a screwdriver as a pry bar. If you cannot remove a component, check to see if there is a clip or latch that is securing the component in place.

Caution

If excessive force is needed to remove or add a component, something is probably wrong. Take a second look to make sure that you have not missed a screw or a locking clip that is holding the component in place. Refer to the device manual or diagram for additional information.

Phillips-Head Screwdriver

Use a Phillips-head screwdriver with crosshead screws. Do not use this type of screwdriver to puncture anything. This will damage the head of the screwdriver.

Hex Driver

Use a hex driver, shown in Figure 2-10, to loosen and tighten bolts that have a hexagonal (six-sided) head. Hex bolts should not be over-tightened because the threads of the bolts can be stripped. Do not use a hex driver that is too large for the bolt that you are using.

Figure 2-10 Hex Driver

Caution

Some tools are magnetized. When working around electronic devices, be sure that the tools you are using have not been magnetized. Magnetic fields can be harmful to data stored on magnetic media. Test your tool by touching the tool with a screw. If the screw is attracted to the tool, do not use the tool.

Component Retrieving Tools

Needle-nose pliers and tweezers can be used to place and retrieve parts that may be hard to reach with your fingers. There are also tools called part retrievers that are specifically designed for this task. Do not scratch or hit any components when using these tools.

Caution

Pencils should not be used inside the computer to change the setting of switches or to pry off jumpers. The pencil lead can act as a conductor and may damage the computer components.

A computer technician needs proper tools to work safely and prevent damage to the computer equipment. A technician uses many tools to diagnose and repair computer problems:

- Straight-head screwdriver, large and small
- Phillips-head screwdriver, large and small
- Tweezers or part retriever
- Needle-nosed pliers
- Wire cutters
- Chip extractor

- Hex wrench set
- Torx screwdriver
- Nut driver, large and small
- Three-claw component holder
- Wire stripper
- Crimper
- Punch-down tool
- Digital multimeter
- Wrap plugs
- Small mirror
- Small dust brush
- Soft, lint-free cloth
- Cable ties
- Scissors
- Small flashlight
- Electrical tape
- Pencil or pen
- Compressed air

Various specialty tools, such as Torx bits, *antistatic bags* and gloves, and integrated circuit pullers, can be used to repair and maintain computers. Always avoid magnetized tools, such as screwdrivers with magnetic heads, or tools that use extension magnets to retrieve small metal objects that are out of reach. Using magnetic tools can cause loss of data on hard drives and floppy disks. Magnetic tools can also induce current, which can damage internal computer components.

Additionally, there are specialized testing devices used to diagnose computer and cable problems:

- **Multimeter:** A device that measures AC/DC voltage, electric current, and other cable and electrical characteristics.
- *Power supply tester*: A device that checks whether the computer power supply is working properly. A simple power supply tester might just have indicator lights, while more advanced versions show the amount of voltage and amperage.
- *Cable tester*: A device that checks for wiring shorts or faults, such as wires connected to the wrong pin.
- *Loopback plug*: A device that connects to a computer, hub, switch, or router port to perform a diagnostic procedure called a loopback test. In a loopback test, a signal is transmitted through a circuit and then returned to the sending device to test the integrity of the data transmission.

Lab 2.2.4.4: Using a Multimeter and a Power Supply Tester

In this lab, you learn how to use and handle a multimeter and a power supply tester. Refer to Lab 2.2.4.4 in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Lab 2.2.4.5: Testing UTP Cables Using a Loopback Plug and a Cable Meter

In this lab, you use a loopback plug and a cable meter to test an Ethernet cable. Refer to Lab 2.2.4.5 in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Cleaning Materials (2.2.4.6)

Keeping computers clean inside and out is a vital part of a maintenance program. Dirt can cause problems with the physical operation of fans, buttons, and other mechanical components. On electrical components, an excessive buildup of dust acts like an insulator and traps the heat. This insulation impairs the ability of heat sinks and cooling fans to keep components cool, causing chips and circuits to overheat and fail.

Note

When using compressed air to clean inside the computer, blow the air around the components with a minimum distance of 4 in. (10 cm) from the nozzle. Clean the power supply and the fan from the back of the case.

Caution

Before cleaning any device, turn it off and unplug the device from the power source.

Computer Cases and Monitors

Clean computer cases and the outside of monitors with a mild cleaning solution on a damp, lint-free cloth. Mix one drop of dishwashing liquid with 4 oz. (118 ml) of water to create the cleaning solution. If water drips inside the case, allow enough time for the liquid to dry before powering on the computer.

LCD Screens

Do not use ammoniated glass cleaners or any other solution on an LCD screen, unless the cleaner is specifically designed for the purpose. Harsh chemicals damage the coating on the screen. There is no glass protecting these screens, so be gentle when cleaning them and do not press firmly on the screen.

CRT Screens

To clean the screens of CRT monitors, dampen a soft, clean, lint-free cloth with distilled water and wipe the screen from top to bottom. Then use a soft, dry cloth to wipe the screen and remove streaking.

Components

Clean dusty components with a can of compressed air. Compressed air does not cause electrostatic buildup on components. Make sure that you are in a well-ventilated area before blowing the dust out of the computer. A best practice is to wear a dust mask to make sure that you do not breathe in the dust particles.

Blow out the dust using short bursts from the can. Never tip the can or use the can upside down. Do not allow the fan blades to spin from the force of the compressed air. Hold the fan in place. Fan motors can be ruined from spinning when the motor is not turned on.

Component Contacts

Clean the contacts on components with isopropyl alcohol. Do not use rubbing alcohol. Rubbing alcohol contains impurities that can damage contacts. Make sure that the contacts do not collect lint from the cloth or cotton swab. Before reinstallation, use compressed air to blow lint off the contacts.

Keyboards

Clean a desktop keyboard with compressed air and then use a handheld vacuum cleaner with a brush attachment to remove the loose dust.

Caution

Never use a standard vacuum cleaner inside a computer case. The plastic parts of the vacuum cleaner can build up static electricity and discharge to the components. Use only vacuums that are approved for electronic components.

Mice

Use glass cleaner and a soft cloth to clean the outside of the mouse. Do not spray glass cleaner directly on the mouse. If cleaning a ball mouse, you can remove the ball and clean it with glass cleaner and a soft cloth. Wipe the rollers clean inside the mouse with the same cloth. Do not spray any liquids inside the mouse.

Table 2-1 shows the computer items that you should clean and the cleaning materials to use.

Table 2-1 Computer Cleaning Materials

Computer case and outside of monitor	Mild cleaning solution and lint-free cloth
LCD screen	LCD cleaning solution or distilled water and lint-free cloth
CRT screen	Distilled water and lint-free cloth

Heat sink	Compressed air
RAM	Isopropyl alcohol and lint-free swab
Keyboard	Handheld vacuum cleaner with a brush attachment
Mouse	Glass cleaner and a soft cloth

Lab 2.2.4.7: Computer Disassembly

In this lab, you disassemble a computer using safe lab procedures and the proper tools. Use extreme care and follow all safety procedures. Familiarize yourself with the tools you will be using in this lab. Refer to Lab 2.2.4.7 in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Summary (2.3.1)

This chapter discussed safe lab procedures, correct tool usage, and the proper disposal of computer components and supplies. You have familiarized yourself in the lab with many of the tools used to build, service, and clean computer and electronic components. You have also learned the importance of organizational tools and how these tools help you work more efficiently.

Some of the important concepts to remember from this chapter:

- Work in a safe manner to protect users and equipment.
- Follow all safety guidelines to prevent injuries to yourself and others.
- Know how to protect equipment from ESD damage.
- Know about and be able to prevent power issues that can cause equipment damage or data loss.
- Know which products and supplies require special disposal procedures.
- Familiarize yourself with the MSDS for safety issues and disposal restrictions to help protect the environment.
- Be able to use the correct tools for the task.
- Know how to clean components safely.
- Use organizational tools during computer repairs.

Summary of Exercises

The following labs and worksheets cover material from this chapter. Refer to the labs and worksheets in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition.

Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition:

Lab 2.2.4.4: Using a Multimeter and a Power Supply Tester

Lab 2.2.4.5: Testing UTP Cables Using a Loopback Plug and a Cable Meter

Lab 2.2.4.7: Computer Disassembly

Worksheets

The following worksheets cover material from this chapter. Refer to the worksheets in *IT Essentials: PC Hardware and Software Lab Manual*, Fifth Edition:

Worksheet 2.2.2.3: Diagnostic Software

Check Your Understanding

You can find the answers to these questions in Appendix A, "Answers to 'Check Your Understanding' Questions."

1. How should a technician discharge static buildup while working on a computer system?

   A. Maintain contact with the painted part of the computer case.
   B. Maintain contact with an unpainted part of the computer case.
   C. Touch an antistatic wrist strap before touching any computer equipment.
   D. Touch an antistatic mat before touching any computer equipment.

2. Which of the following is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first aid requirements?

   A. ESD
   B. MSDS
   C. OSHA
   D. UPS

3. Which two statements are true of static electricity? (Choose two.)

   A. It can distort wireless signals.
   B. More than 10,000 volts can build up on a person.
   C. As few as 30 volts can damage computer components.
   E. It will not harm computer components as long as the computer is plugged in.
   F. Keeping the air cool and dry can decrease the buildup of static electricity.
   G. It is generated by devices such as motors, power lines, and radio transmitters.

4. Which recommendation should be followed first when a fire in the workplace is out of control?

   A. Try to use the elevators to get to the lowest floor faster.
   B. Get out of the room or building and contact emergency services for help.
   C. Use the company water system to stop the fire from extending to other areas.
   D. Try to control the fire with proper extinguishers.

5. Which device is designed specifically to protect computers and electrical devices from excess electrical voltage?

   A. Power strip
   B. Standby power supply
   C. Surge protector
   D. Uninterruptible power supply

6. Which piece of software is designed to protect against unauthorized communications to and from a computer?

   A. Security center
   B. Port scanner
   C. Antimalware
   D. Antivirus
   E. Firewall

7. What is an accepted method for cleaning computer components?

   A. Using ammonia to clean the LCD screen
   B. Using rubbing alcohol to clean component contacts
   C. Using a lint-free cloth to remove dust inside the computer case
   D. Using glass cleaner on a soft cloth to clean the outside of the mouse

8. Which tool would be used to scan Windows critical system files and replace any corrupted files?

   A. SFC
   B. CHKDSK
   C. Fdisk
   D. Defrag

9. Which condition refers to a sudden and dramatic increase in voltage, which is usually caused by lighting?

   A. Brownout
   B. Sag
   C. Spike
   D. Surge

10. Which tool can be used to take resistance and voltage measurements?

   A. Multimeter
   B. Power supply tester
   C. Cable tester
   D. Loopback plug

Index

Symbols

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W-Z