



## *Lesson Plans*

### **CompTIA's A+ Core Hardware**

(Exam 220-301)

Version # 6.1

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## **Course Overview**

The A+ certification is sponsored by CompTIA and is an entry-level certification. It is an industry-wide certification and vendor-neutral. It consists of two exams:

- A+ Core Hardware
- A+ Operating System

This course covers content for the A+ Core Hardware exam. It focuses on how to identify, install, configure, diagnose and implement preventive maintenance procedures for computer hardware in a PC system.

### **Module 0**

Module 0 introduces the student to the A+ Core Hardware certification and covers the prerequisites for the course. Included is a section with hands-on learning to ensure the student becomes skilled at using the hardware simulator. The hardware simulator allows a student to practice installing and configuring hardware on a virtual system.

### **Module 1**

Module 1 teaches the student of basic computer hardware and how to protect and maintain computer components. Included are discussions on the purpose and functionality of the BIOS, CMOS, IRQ, DMA, and I/O addresses.

### **Module 2**

Module 2 focuses on the role and function of PC system components such as system cases, power supplies, motherboard, processors, and memory. Students will learn how to identify the components by sight and how to install the above components.

### **Module 3**

Module 3 discusses the use of expansion slots to customize a PC system. Students will learn to identify different types of expansion slots used to provide connectivity for devices. They will also be given opportunities to select and install different kinds of expansion boards for given scenarios.

### **Module 4**

Module 4 covers the details of peripheral devices. The most common types of PC communication ports are discussed including serial, parallel, and PS/2. Also discussed are the basic facts about newer connectivity options such as USB, Firewire, and infrared. Various types of printing technologies are explained and the factors to consider when selecting a printer. How scanners and digital cameras work and the features available are presented. Students will learn how to select and install different types of peripheral devices.

### **Module 5**

Module 5 discusses storage devices such as floppy drives and hard drives. Several common interfaces are discussed including Parallel ATA (IDE), Serial ATA, and SCSI. The different RAID levels used to protect data on the hard disk are examined. Also

summarized are different types of CD-ROM and DVD devices and their specifications. Students will be given opportunities to install different types of storage devices.

### **Module 6**

Module 6 focuses on the fundamentals of networking. Student will learn why companies choose to install a network and the network devices used to build a network. Students will learn how to identify common cables and connectors used for networking. Also, students will learn how data is sent on a wireless network. Discussed are the most common methods of providing Internet connection and printer capabilities on a network.

### **Module 7**

Module 7 discusses basics about different types of battery powered portable computers such as notebooks, PDAs and tablet PCs. Also discussed, are types of batteries available, power management strategies, and how to upgrade and repair a notebook system.

### **Module 8**

Module 8 discusses upgrades and performance considerations of common computer components such as hard disk drive, memory and CPU.

### **Module 9**

Module 9 presents a basic troubleshooting methodology for identifying and repairing problems. Students will learn what to look for when troubleshooting the PC boot process, system components, storage devices, peripheral devices, and networking devices.

## **Section 0.1: Course Introduction**

### **Preparation**

This section introduces the video instructor, the exam, and the prerequisites to this course.

The prerequisites that are required by the students before taking this course are outlined. Before beginning this course, students should have experience with:

- Using computers
- Basic applications such as a word processor
- Internet
- Basic computing tasks

### **Time**

About 6 minutes

## **Section 0.2: Using the Hardware Simulator**

### **Preparation**

This section is an overview of how to use the hardware simulator included in this course. Experiment with the simulations until you are familiar with how the hardware simulator works. You will recognize the simulations by the mouse icon to the left of the entry.

### **Time**

About 20 minutes

### **Lab/Activity**

- Put an Item on the Workbench
- Select an Item Based on Its Documentation
- Select Item Categories
- Install and Uninstall Components
- Set Dials and Switches
- Add Cabled Components

## Section 1.1: PC Concepts

### Preparation

This section is an overview of basic computer components and the functions they perform. The three basic elements are hardware, software and firmware. Also discussed are the external ports on a desktop PC system. After finishing this section students should be able to identify internal and external PC components by sight.

#### A+ Core Hardware Objectives:

- 1.1 Identify the names, purpose, and characteristics, of system modules. Recognize these modules by sight or definition.
- 1.5 Identify the names, purposes, and performance characteristics, of standardized/common peripheral ports, associated cabling, and their connectors. Recognize ports, cabling, and connectors by sight.

#### Lecture Focus Questions:

- What are the differences between hardware, software, and firmware?
- What are the primary functions of a computer?
- What different types of output and input devices can be attached to your computer?
- What kinds of storage devices are available for a PC?
- How are the concepts of modularization and standardization beneficial in computer usage and maintenance?

### Time

About 45 minutes

## Section 1.2: Protection and Safety

### Preparation

This section discusses the protection and safety of both the computer components and the technicians who are working with computers. The risk of Electro Static Discharge (ESD) damaging your computer components and how to reduce the risk is covered. Concerns about how to safely dispose of used computer components that may have environmental impact are also discussed.

#### A+ Core Hardware Objectives:

- 3.2 Identify various safety measures and procedures, and when/how to use them.
- 3.3 Identify environmental protection measures and procedures, and when/how to use them.

#### Lecture Focus Questions:

- How can ESD be a hazard to electronic computer components?
- What is the difference between a static-shielding bag and a static-resistant bag?
- What steps can you take to reduce ESD if you do not have the proper equipment handy?
- What is the MSDS? When would the information it provides be important?
- What class of fire extinguisher should you keep in a computer repair location? Why?
- Which PC components require extra care to protect your personal safety?

### Time

About 60 minutes

## **Section 1.3: PC Maintenance**

### **Preparation**

This section focuses on how to prevent problems with your system through proper maintenance of ventilation, temperature, humidity, backups, and cleaning of computer components. The tools needed for a computer repair and maintenance tool kit are presented. Sandra, a software used to analyze the hardware on a PC, is demonstrated showing how to diagnose problems or increase performance of your system.

### **A+ Core Hardware Objectives:**

- 3.1 Identify the various types of preventive maintenance measures, products and procedures and when and how to use them.

### **Lecture Focus Questions:**

- Why is dust an enemy to a computer?
- What types of materials can you use to clean internal PC components?
- What will too much, or too little, humidity do to a computer?
- How are backups related to preventive maintenance?
- What is the function of a loopback plug?

### **Time**

About 40 minutes

## Section 1.4: BIOS

### Preparation

This section discusses the functions of the Basic Input/Output Services (BIOS) and the Complementary Metal-Oxide Semiconductor (CMOS) memory chip and how they work together. The CPU can't directly communicate with other devices that are installed on the motherboard. BIOS is a special ROM chip on the motherboard that contains a collection of programs that allows communication with other devices. CMOS contains the parameters the BIOS programs need to access the devices. CMOS is located in a RAM memory chip, which can be written to, allowing parameters to be changed as needed.

### A+ Core Hardware Objectives:

- 4.4 Identify the purpose of CMOS (Complementary Metal-Oxide Semiconductor) memory, what it contains, and how and when to change its parameters. Given a scenario involving CMOS, choose the appropriate course of action.

### Lecture Focus Questions:

- What are the functions of the BIOS?
- What is the role of CMOS? How does it differ from the BIOS?
- Why does the CMOS require a battery?
- What determines the keystroke to open a CMOS editor? How can you find this information?

### Time

About 60 minutes

### Lab/Activity

- Configure the BIOS (Scenario 1)
- Configure the BIOS (Scenario 2)
- Configure the BIOS (Scenario 3)
- Configure the BIOS (Scenario 4)

## Section 1.5: System Resources

### Preparation

This section defines the purpose and functionality of Interrupt Request Channels (IRQ), Direct Memory Access (DMA) channels, and I/O addresses. An IRQ allows a device to interrupt the CPU and request processing time. DMAs allow high-speed devices such as hard drives and CD-ROM drives to read and write directly to RAM, bypassing the CPU. I/O address (port address) is the method used by devices in a computer to communicate with each other and system software. Also discussed is how to configure the system resources used by expansion boards and how to determine the resources that are currently in use in your system.

### A+ Core Hardware Objectives:

- 1.4 Identify typical IRQs, DMAs, and I/O addresses, and procedures for altering these settings when installing and configuring devices. Choose the appropriate installation or configuration steps in a given scenario.

### Lecture Focus Questions:

- What are IRQ interrupts and how do they function?
- What function does the cascade from IRQ 2 to cascade IRQ 9 provide?
- What is the function of a PIC chip?
- How do PCI buses address the problem of limited interrupts?
- What types of devices use DMA channels?
- What is Ultra DMA and how does it effect traditional DMA channel functions?
- How many I/O addresses are available in a typical PC system?
- Why must I/O addresses be unique?
- Why is it important to memorize common IRQ, I/O and DMA assignments?
- How are jumpers and dip switches used in expansion card configuration?
- What resources are required to support plug-and-play?

### Time

About 75 minutes

## Section 2.1: System Cases

### Preparation

This section focuses on the role and function of the PC system cases. Different form factor standards are available and the power supply, system case and motherboard must all use the same form factor. Cases come in different sizes depending upon the purpose of the system. Point out the different sizes and form factors of the system cases that are in use in your classroom.

#### A+ Core Hardware Objectives:

- 1.1 Identify the names, purpose, and characteristics of system modules.  
Recognize these modules by sight or definition.
- 4.3 Identify the most popular types of motherboards, their components, and their architecture (bus structures).

#### Lecture Focus Questions:

- What components should be delivered with a system case?
- What are the considerations when choosing a type of system case?
- How can a motherboard layout determine what steps you need to take to prepare a system case?
- What risk do you run if you install the motherboard before removing the slot covers?

### Time

About 15 minutes

## **Section 2.2: Power Supplies**

### **Preparation**

This section covers the role of a power supply to convert AC current to DC current. Students will learn how to diagnose and swap out a failing power supply, and also how to select and configure an Uninterruptible Power Supply (UPS) to protect the system.

### **A+ Core Hardware Objectives:**

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

### **Lecture Focus Questions:**

- What are common standards measuring amount of power required by a computer system?
- How do you determine what size of power supply is required for a specified computer?
- Why is it important to read the documentation when connecting power and case cables?
- How do power supplies address heat control?
- What is soft power?
- What are common symptoms of power supply problems?
- Why shouldn't you attempt to open or repair a failed power supply?
- What is the difference between a brownout and a blackout?
- How does a UPS differ from a surge protector?

### **Time**

About 70 minutes

### **Lab/Activity**

- Connect Power and Case Cables

## Section 2.3: Motherboards

### Preparation

This section discusses the basic facts about motherboards. The components of a typical motherboard are identified with their location and function. The student will learn how to select and install a motherboard and how to configure motherboard settings with software and/or jumpers.

#### A+ Core Hardware Objectives:

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 4.3 Identify the most popular types of motherboards, their components, and their architecture (bus structures).

#### Lecture Focus Questions:

- What is the difference between the northbridge and southbridge chips on a motherboard?
- When might you need to set motherboard jumpers?
- What is the difference between a motherboard header and the faceplate connectors?
- What components are used to attach the motherboard to the mounting plate and how do you determine where these components are installed on the mounting plate?
- What factors will you consider when selecting a motherboard?

### Time

About 60 minutes

### Lab/Activity

- Choose a Motherboard (Scenario 1)
- Choose a Motherboard (Scenario 2)
- Configure Motherboard Jumpers (Scenario 1)
- Configure Motherboard Jumpers (Scenario 2)

## Section 2.4: Processors

### Preparation

This section discusses modern processors or CPUs that have been implemented over the last few years. Also discussed are the procedures for installing a CPU in a motherboard. Students will practice identifying the correct processor for a given motherboard and installing the processor, heatsink, and fan on the motherboard.

#### A+ Core Hardware Objectives:

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 4.1 Distinguish between the popular CPU chips in terms of their basic characteristics.

#### Lecture Focus Questions:

- How does the CPU socket style determine which CPU could be installed in a specified computer?
- What factors should be considered when comparing the speed of computers?
- What is a multiplier?
- How do you determine the placement of the CPU on the zip socket?
- How do Level I, Level II, and Level III cache differ?
- Which CPU feature(s) might be required by a computer used for multimedia development?
- What are the AMD equivalents to the different Intel Pentiums?
- What methods are used to dissipate CPU generated heat?
- What distinguishes an Athlon 64 from earlier CPUs?
- Which sockets are used by the Pentium EE, Pentium M, and the Xeon processors?

### Time

About 85 minutes

### Lab/Activity

- Install a Processor (Scenario 1)
- Install a Processor (Scenario 2)
- Install a Processor (Scenario 3)
- Install a Processor (Scenario 4)
- Install a Processor (Scenario 5)
- Install a CPU fan

## Section 2.5: Memory

### Preparation

This section presents the role and function of RAM (Random Access Memory) in PC systems. RAM is non-persistent and data only remains in RAM as long as the computer is powered up. Two types of RAM are discussed and the various RAM technologies employed over the past few years. Students will learn how to select memory according to system requirements and how to install memory on a specified motherboard. They should be able to identify if memory can be installed singly or must be installed in pairs.

### A+ Core Hardware Objectives:

- 1.2. Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 4.2 Identify the types of RAM (Random Access Memory), form factors, and operational characteristics. Determine banking and speed requirements under given scenarios.

### Lecture Focus Questions:

- What are some of the characteristics of memory to consider when selecting memory?
- How do you determine the amount of memory to install to fill a memory bank?
- What is the difference between SRAM and DRAM?
- What is the difference between static RAM and dynamic RAM?
- What features other than memory capacity and speed effect memory performance?
- Besides counting the number of pins, how can you tell the difference between 168-pin DIMMs and DDR modules? How can you tell the difference between DDR and DDR-2 modules?
- When might you need to edit the BIOS when installing additional memory?
- What is the difference between ECC and registered memory?

### Time

About 2 hours and 25 minutes

### Lab/Activity

- Install Memory (Scenario 1)
- Install Memory (Scenario 2)
- Install Memory (Scenario 3)
- Install Memory (Scenario 4)

- Install Memory (Scenario 5)
- Install Memory (Scenario 6)
- Install Memory (Scenario 7)
- Install Memory (Scenario 8)
- Install Memory (Scenario 9)
- Install Memory (Scenario 10)
- Install Memory (Scenario 11)
- Disable Memory Tests

## Section 3.1: Expansion Buses and Slots

### Preparation

This section explains the different types of expansion slots used to provide connectivity for devices. Students will learn how to identify different expansion slots and the steps to install an expansion board. Also discussed are the factors to consider to protect the expansion card and slot from damage.

#### A+ Core Hardware Objectives:

- 1.1 Identify the names, purpose, and characteristics of system modules. Recognize these modules by sight or definition.
- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 4.3 Identify the most popular types of motherboards, their components, and their architecture (bus structures).

#### Lecture Focus Questions:

- What is the difference between bus clock speed and CPU clock speed?
- What is the advantage of bus mastering?
- What is an advantage of the PCI bus over the ISA bus?
- Which buses are commonly used by graphics cards?

### Time

About 15 minutes

## **Section 3.2: EISA, ISA, and PCI**

### **Preparation**

This section discusses customizing a modular PC system through the use of the expansion bus. Students will become familiar with I/O bus implementations that have been used over the years. They will understand the limitations and advantages of each implementation. They are given opportunities to practice selecting and installing the correct expansion card to meet the requirements for a given scenario.

#### **A+ Core Hardware Objectives:**

- 4.3 Identify the most popular types of motherboards, their components, and their architecture (bus structures).

#### **Lecture Focus Questions:**

- What are the advantages of a PCI card over EISA and ISA cards?
- What is the benefit of having both PCI and ISA slots on a motherboard?
- What are the limitations of a shared PCI and ISA slot?

### **Time**

About 50 minutes

### **Lab/Activity**

- Install an ISA Card (Scenario 1)
- Install an ISA Card (Scenario 2)
- Install a PCI Card (Scenario 1)
- Install a PCI Card (Scenario 2)

## **Section 3.3: AMR, ACR, and CNR**

### **Preparation**

This section discusses how riser cards are used to provide communication functionality supporting audio, modem, network, and DSL interfaces in PC systems. Three types of standards are discussed and the types of communication devices each supports. Students will learn how to identify and install the correct riser card in the correct slot.

#### **A+ Core Hardware Objectives:**

- 4.3 Identify the most popular types of motherboards, their components, and their architecture (bus structures).

#### **Lecture Focus Questions:**

- On which type of motherboard is a CNR card usually found?
- Where is the CNR slot usually located?
- What other cards will an ACR slot accept?
- What are the advantages of ACR cards?

### **Time**

About 20 minutes

### **Lab/Activity**

- Install a Riser Card (Scenario 1)
- Install a Riser Card (Scenario 2)

## **Section 3.4: VESA and AGP**

### **Preparation**

This section discusses the expansion bus standards used for video interfaces. The capabilities of each standard are discussed. Students will learn how to select and install the correct card to meet given requirements.

#### **A+ Core Hardware Objectives:**

- 4.3 Identify the most popular types of motherboards, their components, and their architecture (bus structures).

#### **Lecture Focus Questions:**

- What are the disadvantages of the VESA?
- What capabilities of AGP helps to provide faster graphics for a computer?
- What is the difference between AGP 2x, 4x, and 8x specifications and device appearance?

### **Time**

About 40 minutes

### **Lab/Activity**

- Install an AGP Card (Scenario 1)
- Install an AGP Card (Scenario 2)
- Install an AGP Card (Scenario 3)
- Install an AGP Card (Scenario 4)

## Section 3.5: Video Cards

### Preparation

This section covers the role and function of video cards in a PC system acting as an interface between the motherboard and monitor. The video card takes data from the motherboard and converts it into data that can be displayed on the monitor. The different components that make up the video card are discussed as well as considerations to increase performance when selecting a video card for a PC system. Also discussed are two different processes to implement dual monitor support. Students will learn how to identify digital and analog connectors and be able to select and install the appropriate video card for a given scenario.

### A+ Core Hardware Objectives:

- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.
- 1.9 Identify procedures to optimize PC operations in specific situations. Predict the effects of specific procedures under given scenarios.

### Lecture Focus Questions:

- What are the two most common video card buses used to day? What other two bus types are common in older systems?
- What is the advantage of having a processor and memory on a video card?
- How does the color depth and resolution depend on the amount of video card memory?
- What is the difference between a TV tuner and VI/VO?
- What are the advantages and disadvantages of using a motherboard with built-in video?
- What must you do when replacing the built-in video with an AGP video card?

### Time

About 30 minutes

### Lab/Activity

- Install a Video Card (Scenario 1)
- Install a Video Card (Scenario 2)

## Section 3.6: Monitors

### Preparation

This section discusses the basic facts about CRT and LCD monitors, consisting of how the monitors work and each monitor's components and features. Students will learn how to identify monitor connects and how to select the appropriate monitor for a given situation. No specific objectives have been assigned to this section.

### Lecture Focus Questions:

- What terms are used to rate the quality of monitors?
- What feature of a non-interlaced monitor makes it a better quality than an interlaced monitor?
- What is the best way to clean a monitor?
- What monitor adjustments are available to fine-tune the monitor display?
- What are the most common factors to look at when troubleshooting a monitor?
- Why is it a bad idea to open a monitor case without special training?

### Time

About 60 minutes

### Lab/Activity

- Install a VGA Device
- Install a DVI Device (Scenario 1)
- Install a DVI Device (Scenario 2)
- Install a DVI Device (Scenario 3)
- Install a Monitor (Scenario 1)
- Install a Monitor (Scenario 2)

## **Section 3.7: Sound Cards and Devices**

### **Preparation**

This section covers the role of a sound card to manage sound input and output by converting digital data to analog sound for output and converting analog sound to digital data for input. Also covered are the features one must consider when purchasing a sound card. Students will learn how to select the correct sound card and speakers for given requirements and create a multi-media system by installing sound devices.

### **A+ Core Hardware Objectives:**

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

### **Lecture Focus Questions:**

- What are some of the main features you might consider when choosing a sound card?
- What speaker configuration does Dolby Digital use?
- What is the difference between a WAV file and a MIDI file?
- What are the common connectors that might be on a sound card?

### **Time**

About 40 minutes

### **Lab/Activity**

- Install Sound Devices (Scenario 1)
- Install Sound Devices (Scenario 2)
- Install Sound Devices (Scenario 3)

## Section 4.1: Serial, Parallel, and PS/2

### Preparation

This section explains the role and function of PC communication ports by explaining common types of ports available, how they work, common peripheral devices they may be attached to, and the advantages and disadvantages of each communication port type. Common input devices are also discussed. Students will learn how to select and install peripheral devices.

#### A+ Core Hardware Objectives:

- 1.5 Identify the names, purposes, and performance characteristics, of standardized/common peripheral ports, associated cabling, and their connectors. Recognize ports, cabling, and connectors, by sight.
- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.
- 5.1 Identify printer technologies, interfaces, and options/upgrades.

#### Lecture Focus Questions:

- What is the difference between serial and parallel communications?
- Theoretically which form of communication (serial or parallel) provides faster communication?
- Generally speaking, which form of communication (serial or parallel) will provide communication over longer distances without amplification?
- What is the relationship between the serial port and the COM ports? Between the parallel port and LPT ports?
- What is the difference between SPP and EPP standards?
- How do you configure a computer to use EPP?
- When selecting a keyboard, what are some of the special features available you could consider?

### Time

About 1 hour and 30 minutes

### Lab/Activity

- Install PS/2 Devices
- Install a Serial Device
- Network a Computer Using a Null Modem Serial Cable
- Install a Parallel Device
- Install Two Parallel Devices

## Section 4.2: USB

### Preparation

This section provides information about USB (Universal Serial Bus), which is a newer technology replacing much of the serial and parallel implementations. USB is a high-speed communication standard that eliminates the need for separate ports for separate devices. Also discussed are common USB connectors, features and versions available, and the methods employed to connect USB devices to a PC system.

#### A+ Core Hardware Objectives:

- 1.5 Identify the names, purposes, and performance characteristics, of standardized/common peripheral ports, associated cabling, and their connectors. Recognize ports, cabling, and connectors, by sight.
- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.

#### Lecture Focus Questions:

- What are the differences between USB 1.1 and 2.0?
- What types of devices are typically self-powered? Bus-powered?
- What are the power requirements for a low-powered and high-powered bus powered-device?
- Which computer operating systems support USB?

### Time

About 60 minutes

### Lab/Activity

- Install USB Devices (Scenario 1)
- Install USB Devices (Scenario 2)
- Install USB Devices (Scenario 3)
- Install USB Devices (Scenario 4)
- Install USB Devices (Scenario 5)
- Install a Keyboard
- Install a Mouse

## **Section 4.3: IEEE 1394 (Firewire/I-Link/DV)**

### **Preparation**

This section discusses basic facts about the Firewire standard, a high capacity connectivity option used for high speed audio and video transfers that can be implemented with devices such as external hard drives, CDs and DVDs, and digital cameras. Also presented are the two different types of connectors used and Firewire specifications. Students will learn how to install an expansion card that supports Firewire and connect peripheral devices to a Firewire port.

### **A+ Core Hardware Objectives:**

- 1.5 Identify the names, purposes, and performance characteristics, of standardized/common peripheral ports, associated cabling, and their connectors. Recognize ports, cabling, and connectors, by sight.
- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.

### **Lecture Focus Questions:**

- Which operating systems support IEEE 1394?
- What are the additional functions of a six-wire IEEE 1394 over a four-wire IEEE 1394 cable?
- What is the maximum cable length of a 1394 cable?
- What are common devices that use IEEE 1394?

### **Time**

About 25 minutes

### **Lab/Activity**

- Install IEEE 1394 Devices (Scenario 1)
- Install IEEE 1394 Devices (Scenario 2)
- Install IEEE 1394 Devices (Scenario 3)

## **Section 4.4: Infrared (IrDA)**

### **Preparation**

This section discusses how infrared can be used allow communication between PC systems and wireless peripherals. The basic infrared specifications and limitations are discussed and the steps to enable infrared are outlined.

#### **A+ Core Hardware Objectives:**

- 1.5 Identify the names, purposes, and performance characteristics, of standardized/common peripheral ports, associated cabling, and their connectors. Recognize ports, cabling, and connectors, by sight.

#### **Lecture Focus Questions:**

- What are the characteristics of different infrared specifications?
- How can the degree of viewing angle affect the distance of connections?
- What are the functions of an infrared transceiver?

### **Time**

About 10 minutes

## Section 4.5: Printers

### Preparation

This section explains various types of printing technologies that are available and the factors that are considered when selecting a printer. The printer process for each is discussed and the components that allow for the printing process. A variety of printing interfaces are presented. Students will learn how to choose and install an appropriate printer for a given situation and use the correct cabling, connectors, and ports.

#### A+ Core Hardware Objectives:

- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.
- 5.1 Identify printer technologies, interfaces, and options/upgrades.
- 5.2 Recognize common printer problems and techniques used to resolve them.

#### Lecture Focus Questions:

- Which printer type is ideal for printing carbon-copy documents?
- What is a common application for a thermal printer?
- What features are used to describe the quality and speed of print jobs a printer can produce?
- What types of materials should you not print on with a laser printer?
- Why does a laser printer use heat in the printing process?
- What function is performed during the transferring stage in laser printing?
- What precautions should you take when cleaning up toner spills?
- What is the function of the printer driver?

#### Time

About 1 hour and 25 minutes

#### Lab/Activity

- Install a Printer (Scenario 1)
- Install a Printer (Scenario 2)

## **Section 4.6: Scanners and Digital Cameras**

### **Preparation**

This section discusses how scanners and digital cameras work. It also discusses the features of each to consider when selecting a scanner or digital camera. Students will learn how to select and install the appropriate scanner for required specifications.

#### **A+ Core Hardware Objectives:**

- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.

#### **Lecture Focus Questions:**

- What is the function of the CCD microchip?
- What are common interfaces used for scanners?
- What products should you use to clean the scanner bed?
- How do camera megapixels relate to image quality and size?

### **Time**

About 35 minutes

### **Lab/Activity**

- Install a Scanner

## **Section 5.1: Floppy**

### **Preparation**

This section describes how floppy disks work, the specifications of the two sizes available, and the precautions to maintain floppy disks. Students will learn how to install both a single floppy drive and dual floppy drives, and how to connect the appropriate cables.

#### **A+ Core Hardware Objectives:**

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

#### **Lecture Focus Questions:**

- How does the floppy disk density affect storage capacity?
- What elements can you visually inspect to ensure the floppy cable was installed correctly?
- What cabling scheme is used to identify drive A: from drive B:?
- What precautions should you take with floppy disks?
- What method do you use to clean the read/write heads of the floppy disk?

### **Time**

About 45 minutes

### **Lab/Activity**

- Install a Floppy Drive
- Install Two Floppy Drives

## **Section 5.2: Hard Drives**

### **Preparation**

In this section students will learn how hard disk drives work in the PC system, the components of a hard disk, and the geometry or properties of a hard disk. Students will learn what factors to consider when selecting a hard disk for a PC system.

### **A+ Core Hardware Objectives:**

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.

### **Lecture Focus Questions:**

- What is the difference between a hard disk sector and a track?
- How does disk caching improve performance?
- How is a disk drive prepared before an operating system can be installed?
- What measures are used to describe hard drive performance?

### **Time**

About 30 minutes

## Section 5.3: Parallel ATA (IDE)

### Preparation

This section discusses the differences between three distinct standards; IDE, EIDE, and ATA. In the industry the terms may be used interchangeably. The Master/Slave relationship is also discussed and the process for installing an ATA device. Students will learn how to select the appropriate drive for given requirements, how to install a single hard drive, and how to configure the Master/Slave setting when installing two devices on one controller.

### A+ Core Hardware Objectives:

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 1.6 Identify proper procedures for installing and configuring common IDE devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.

### Lecture Focus Questions:

- What makes IDE a popular choice of hard drive?
- What are the differences between IDE, EIDE, and ATA?
- What is the method for identifying the master/slave configuration of hard drives?
- What type of cable do ATA devices require?
- Why are DMS modes, rather than PIO modes, used on newer drives?

### Time

About 70 minutes

### Lab/Activity

- Install ATA Devices (Scenario 1)
- Install ATA Devices (Scenario 2)
- Install ATA Devices (Scenario 3)
- Install ATA Devices (Scenario 4)
- Install ATA Devices (Scenario 5)

## **Section 5.4: Serial ATA**

### **Preparation**

This section explains how Serial ATA is the next generation in storage standards and is designed to overcome the limitations of parallel technology. Students will learn how to install a SATA drive, attaching data and power cables.

#### **A+ Core Hardware Objectives:**

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 1.6 Identify proper procedures for installing and configuring common IDE devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.

#### **Lecture Focus Questions:**

- How does SATA improve upon the limitations of ATA?
- How does the application of point-to-point communication increase SATA performance?
- How is configuring SATA easier than configuring ATA?

### **Time**

About 15 minutes

## Section 5.5: SCSI

### Preparation

This section presents the SCSI standard and the steps to configure SCSI devices. SCSI is usually used in high-performance systems to connect hard disks, tape drives, and CD-ROM drives. Students will learn how to select and install SCSI devices, build a SCSI chain, set unique SCSI ID numbers for all devices on the SCSI chain, and terminate appropriate devices on the SCSI chain.

#### A+ Core Hardware Objectives:

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 1.7 Identify proper procedures for installing and configuring common SCSI devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.

#### Lecture Focus Questions:

- What are the advantages of using SCSI devices?
- What factors would you consider when assigning a SCSI ID number?
- What is prevented by proper termination of SCSI devices?
- What factors determine the maximum length of a SCSI bus?

### Time

About 80 minutes

### Lab/Activity

- Install SCSI Devices (Scenario 1)
- Install SCSI Devices (Scenario 2)
- Install SCSI Devices (Scenario 3)
- Install SCSI Devices (Scenario 4)
- Install SCSI Devices (Scenario 5)
- Install SCSI Devices (Scenario 6)

## Section 5.6: Optical Media

### Preparation

This section discusses CD-ROM and DVD devices. It discusses the different types, limitations, and specifications of each type. Students will learn what factors to consider when selecting an optical drive and how to install IDE CD-ROM and DVD devices.

#### A+ Core Hardware Objectives:

- 1.2 Identify basic procedures for adding and removing field-replaceable modules for desktop systems. Given a replacement scenario, choose the appropriate sequences.
- 1.6 Identify proper procedures for installing and configuring common IDE devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.

#### Lecture Focus Questions:

- What does the book color of the compact disc formats identify?
- What is the difference between DVD-R and DVD+R? Are the two standards compatible?
- What precautions should you take when working with CDs?
- An optical drive speed is identified as 24x10x70. What do each of the numbers indicate?
- How do you prevent buffer underrun errors?

### Time

About 35 minutes

### Lab/Activity

- Install a CD or DVD Drive (Scenario 1)
- Install a CD or DVD Drive (Scenario 2)

## **Section 5.7: Choose a Storage Solution**

### **Preparation**

In this section students are given additional opportunities to practice selecting and installing the correct drives. No *Lecture Focus Questions* have been assigned to this section.

#### **A+ Core Hardware Objectives:**

- 1.6 Identify proper procedures for installing and configuring common IDE devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.

### **Time**

About 10 minutes

### **Lab/Activity**

- Install a Hard Drive (Scenario 1)
- Install a Hard Drive (Scenario 2)

## **Section 5.8: Disk Protection**

### **Preparation**

This section discusses how to protect data on the hard disk by creating RAID volumes. The description and characteristics of each RAID level are discussed.

#### **A+ Core Hardware Objectives:**

- 1.6 Identify proper procedures for installing and configuring common IDE devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.
- 1.7 Identify proper procedures for installing and configuring common SCSI devices. Choose the appropriate installation or configuration sequences in given scenarios. Recognize the associated cables.

#### **Lecture Focus Questions:**

- Why are standard backups not sufficient for data loss protection?
- What is the difference between mirroring, striping, duplexing, and parity?
- What is the difference between RAID 1 and RAID 5?
- Which RAID level does not provide fault tolerance?
- Which RAID level does not provide an increase in performance?
- Which RAID level does not have any overhead?
- How are spanned volumes inferior to RAID volumes?

### **Time**

About 15 minutes

## Section 6.1: Networking Basics

### Preparation

This section discusses the basics of networking and how a network works. It discusses the reasons why companies choose to network, the components that are used to create a network, and the different types of networks and network protocols.

#### A+ Core Hardware Objectives:

6.2 Identify basic networking concepts including how a network works.

#### Lecture Focus Questions:

- How does a network increase productivity and decrease hardware costs?
- Which networking type would you select if you had a small network without servers?
- What is the role of a networking protocol?
- Which protocol suite is used on the Internet?
- What is the difference between a MAC address and an IP address? Which address can you assign to a computer?
- How does the IP address indicate both the network and the node address? What is used to identify each part of the address?
- What is the default subnet mask for the IP address 166.88.1.45?

### Time

About 60 minutes

## **Section 6.2: Ethernet Networks**

### **Preparation**

In this section students will learn the various types of network devices needed to build a network. They will learn how Ethernet works and the different types of communication that can occur on a network.

#### **A+ Core Hardware Objectives:**

- 6.1 Identify the common types of network cables, their characteristics and connectors.
- 6.2 Identify basic networking concepts including how a network works.

#### **Lecture Focus Questions:**

- What is the advantage of using a switch over a hub?
- When would you use a router instead of a hub or a switch?
- When can you turn off collision detection on an Ethernet network?

### **Time**

About 30 minutes

## Section 6.3: Cables and Connectors

### Preparation

This section discusses three types of cables and connectors used to connect computers together into a network; coaxial, twisted pair, and fiber optic.

#### A+ Core Hardware Objectives:

- 6.1 Identify the common types of network cables, their characteristics and connectors.
- 6.2 Identify basic networking concepts including how a network works.

#### Lecture Focus Questions:

- What is the difference between RJ-11 and RJ-45 connectors?
- Which twisted pair cable type would you select for a 100BaseT implementation?
- What is an advantage of using fiber optic cables over twisted pair or other copper cable media?
- What is the difference between multi-mode and single-mode fiber optic cable?
- Which cable type and connector is used on 10Base2 networks?

### Time

About 70 minutes

### Lab/Activity

- Network a Computer Using a LAN Adapter (Scenario 1)
- Network a Computer Using a LAN Adapter (Scenario 2)
- Network a Computer Using a LAN Adapter (Scenario 3)

## **Section 6.4: Dial-up Networking**

### **Preparation**

This section covers the role of modems, types of modems and connectors, and the function of AT commands. Students will learn how to network a computer using a modem.

#### **A+ Core Hardware Objectives:**

- 6.2 Identify basic networking concepts including how a network works.
- 6.3 Identify common technologies available for establishing Internet connectivity and their characteristics.

#### **Lecture Focus Questions:**

- What is the purpose of a modem?
- What is the data transfer speed identified by the V.34 standard?
- How does an external modem typically connect to the computer?
- What are common sources of failure for modem transmissions?
- What are the functions of the AT commands?

### **Time**

About 30 minutes

### **Lab/Activity**

- Network a Computer Using a Modem

## Section 6.5: Wireless Networking

### Preparation

This section helps students to understand how data is sent on a wireless network. The specifications of different 802.11 standards are presented and the details of wireless networking architecture.

#### A+ Core Hardware Objectives:

- 1.8 Identify proper procedures for installing and configuring common peripheral devices. Choose the appropriate installation or configuration sequences in given scenarios.
- 6.2 Identify basic networking concepts including how a network works.
- 6.3 Identify common technologies available for establishing Internet connectivity and their characteristics.

#### Lecture Focus Questions:

- What are some reasons to implement, or avoid using, a wireless network?
- What are the differences between the 802.11a, 802.11b, and 802.11g wireless standards? Which standard offers the greatest speed and range? Which two standards are typically compatible?
- What wireless device is like a hub or a switch?
- When would you choose an ad-hoc configuration over an infrastructure configuration?
- What is the function of WEP and WPA?

### Time

About 30 minutes

## **Section 6.6: Internet Connectivity**

### **Preparation**

This section discusses the methods used to connect computers to the Internet through an ISP (Internet Service Provider). The two most common methods of providing Internet connection are through dialup or LAN.

### **A+ Core Hardware Objectives:**

- 6.2 Identify basic networking concepts including how a network works.
- 6.3 Identify common technologies available for establishing Internet connectivity and their characteristics.

### **Lecture Focus Questions:**

- What are the advantages and disadvantages of different types of Internet connections?
- How does a cable modem differ from a standard modem or a DSL router?
- How does the nature of signal interference change with the different types of Internet connection and how can these problems be mitigated?
- What are the disadvantages of a satellite Internet connection?
- How does DSL enable you to talk on the phone and connect to the Internet at the same time?

### **Time**

About 25 minutes

## **Section 6.7: Network Printing**

### **Preparation**

This section helps students to understand how to use network printing to create a more efficient network environment. An overview is presented of two types of network printers, the printing process, and the components of the printing process.

#### **A+ Core Hardware Objectives:**

5.1 Identify printer technologies, interfaces, and options/upgrades.

#### **Lecture Focus Questions:**

- What are the benefits and drawbacks of network printing?
- Why is a print server a useful component on a network?
- What are some of the different configurations for adding a print server to a network?
- What are some different options for connecting a printer to a network?

### **Time**

About 15 minutes

## **Section 7.1: Portable Devices**

### **Preparation**

This section discusses battery-powered portable computers such as notebooks, PDAs and tablet PCs. Different types of PCMCIA cards and notebook batteries used with portable devices are discussed as well as the function of a docking station. The students should be able to identify external notebook components when they have completed this section.

#### **A+ Core Hardware Objectives:**

- 1.1 Identify the names, purpose, and characteristics, of system modules. Recognize these modules by sight or definition.
- 1.3 Identify basic procedures for adding and removing field-replaceable modules for portable systems. Given a replacement scenario, choose the appropriate sequences.
- 1.10 Determine the issues that must be considered when upgrading a PC. In a given scenario, determine when and how to upgrade system components.

#### **Lecture Focus Questions:**

- How do you transfer data from a PDA to a desktop computer?
- What is the function of the docking station?
- What kinds of components are typically built into a notebook computer?
- How do you add devices to a portable device?
- What size slot is required for the different types of PC cards?

### **Time**

About 40 minutes

## **Section 7.2: Power and Device Management**

### **Preparation**

This section covers special power management strategies that can be employed to assist in stretching the battery life of portable computers. Two different standards used to implement power management in PC systems are presented. Advanced Power Management (APM) is an older standard that has been in most instances replaced by the newer standard, Advanced Configuration and Power Interface (ACPI). To implement power management the BIOS, devices, and the operating system must all support power management. Also discussed are the characteristics of different types of batteries used with portable devices.

### **A+ Core Hardware Objectives:**

- 1.3 Identify basic procedures for adding and removing field-replaceable modules for portable systems. Given a replacement scenario, choose the appropriate sequences.
- 1.10 Determine the issues that must be considered when upgrading a PC. In a given scenario, determine when and how to upgrade system components.

### **Lecture Focus Questions:**

- What is the battery memory effect that is present in Ni-cad batteries?
- What advantages do NiMH batteries have over Li-Ion batteries?
- How should you dispose of notebook batteries?
- What is the difference between APM and ACPI?
- Which ACPI power level saves the contents of RAM onto disk?

### **Time**

About 20 minutes

## Section 7.3: Upgrade and Repair

### Preparation

This section demonstrates how to upgrade and repair a notebook system. Specifically the students will learn how to replace the following notebook components: a hard disk drive, memory, and a keyboard. Students are advised that because notebook parts are not as standardized as PC components it is imperative that the students consult the documentation to locate the component and the procedures needed to perform the desired repair.

### A+ Core Hardware Objectives:

- 1.3 Identify basic procedures for adding and removing field-replaceable modules for portable systems. Given a replacement scenario, choose the appropriate sequences.

### Lecture Focus Questions:

- How do you identify the location and replacement procedures for notebook systems?
- How can you tell if a failed notebook display is caused by the display or the video card?
- How can you continue to use a notebook if a built-in component (such as a keyboard, pointing device, or network card) fails?

### Time

About 20 minutes

## **Section 8.1: Upgrading Components**

### **Preparation**

This section discusses the issues that must be taken into consideration when upgrading common components such as a hard disk drive, memory, and CPU. It also discusses what components can be upgraded or added to a printer to increase printer capacity and functionality. Issues that must be considered when flashing the BIOS (reprogramming the EEPROM chip with an updated BIOS program) are also covered.

### **A+ Core Hardware Objectives:**

- 1.9 Identify procedures to optimize PC operations in specific situations.  
Predict the effects of specific procedures under given scenarios.
- 1.10 Determine the issues that must be considered when upgrading a PC. In a given scenario, determine when and how to upgrade system components.

### **Lecture Focus Questions:**

- Which system component, when upgraded, often results in the most performance gains?
- How can you ensure that you purchase the correct memory modules for your system?
- What are the common signs that a computer needs additional memory?
- What compatibility issues must be addressed when upgrading a processor?  
A motherboard?
- Are USB interfaces backward compatible?
- What hazards are to be avoided when flashing the BIOS?
- What factors should determine whether a printer should be upgraded?

### **Time**

About 55 minutes

## **Section 8.2: Performance and Maintenance**

### **Preparation**

This section explains measures that must be taken to ensure performance of the PC system. Students will learn the various methods used to keep the system cool, such as fans, heat sinks, the temperature of the room, and liquid cooling. Students will also learn how to check a hard disk for errors, defragment a hard disk and perform a disk cleanup.

#### **A+ Core Hardware Objectives:**

- 1.9 Identify procedures to optimize PC operations in specific situations.  
Predict the effects of specific procedures under given scenarios.
- 3.1 Identify the various types of preventive maintenance measures, products and procedures and when and how to use them.
- 5.1 Identify printer technologies, interfaces, and options/upgrades.

#### **Lecture Focus Questions:**

- How does adequate cooling improve performance and extend the life of components?
- How does organizing and attaching cables and wires in and around a computer system help with internal airflow?
- Why should you keep the system case cover on during normal operations?
- When might you want to add liquid cooling to a computer?
- What is the difference between a heat sink and a heat spreader?
- What can be done about disk errors?
- Why is the server room often the coldest room in a building?

### **Time**

About 30 minutes

## **Section 9.1: Overview**

### **Preparation**

This section discusses the importance of developing a troubleshooting methodology to identify and repair problems. Students are presented with a systematic approach to problem solving and tips for troubleshooting.

#### **A+ Core Hardware Objectives:**

- 2.2 Identify basic troubleshooting procedures and tools, and how to elicit problem symptoms from customers. Justify asking particular questions in a given scenario.

#### **Lecture Focus Questions:**

- When is it wise to deviate from a systematic troubleshooting approach?
- What place does intuition have in the troubleshooting process?
- Which troubleshooting step is rarely executed, that, if completed, would save countless hours of future effort?
- How could user education be a beneficial step in the troubleshooting process?

### **Time**

About 20 minutes

## **Section 9.2: System Startup**

### **Preparation**

This section discusses troubleshooting the PC boot process. All the steps that must be performed for the boot process to successfully complete are presented, as is the role of POST in the boot process. The cause and symptoms of loss of data in a CMOS chip is also discussed. An overview of audible and visible error codes is outlined for the students.

#### **A+ Core Hardware Objectives:**

- 2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.

#### **Lecture Focus Questions:**

- What problem is indicated when the computer beeps 9 times upon booting?
- When an error 300 is displayed during a POST, a problem with which component is most likely?
- What possible problems can be indicated by slow clock or incorrect data in the CMOS?

### **Time**

About 25 minutes

## Section 9.3: System Components

### Preparation

This section discusses troubleshooting of CPU, memory, expansion boards and slots. Students will learn common symptoms of these components when they fail and how to test and diagnose the problems. Students will also learn how to enable the memory test in the CMOS setup program and how to conduct memory tests using third-party software applications.

### A+ Core Hardware Objectives:

- 2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.

### Lecture Focus Questions:

- What is most likely to cause a CPU problem?
- What should be checked when, after installing memory, the computer reboots and the screen remains blank?
- How can you tell the difference between a memory error caused by hardware and one caused by software?
- How can upgrading the driver eliminate device errors?
- What are the symptoms of a bad power supply?

### Time

About 50 minutes

## Section 9.4: Storage Devices

### Preparation

This section focuses on the troubleshooting of hard disk and floppy drives. Students will learn the basic steps to troubleshoot a hard disk drive, how to properly configure the hardware components, and how to configure the necessary settings.

#### A+ Core Hardware Objectives:

- 2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.

#### Lecture Focus Questions:

- What is the first thing that should be done when a hard drive begins to manifest problems?
- What should be done to an IDE drive before installing it into the system case?
- What are the two most common problems when installing or replacing SCSI devices?
- When replacing a hard drive, why might a BIOS configuration be unnecessary?
- What can cause a floppy drive light to remain lit constantly?
- Why should sector translation be used only when a hard drive is initially installed?

### Time

About 30 minutes

## **Section 9.5: Peripheral Devices**

### **Preparation**

This section covers troubleshooting of printing, video and audio devices. Common peripheral problems are discussed and recommendations to be considered are presented.

#### **A+ Core Hardware Objectives:**

- 2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.
- 5.2 Recognize common printer problems and techniques used to resolve them.

#### **Lecture Focus Questions:**

- How do you clean an ink jet printer head?
- For a laser printer, what can cause the toner to fall off the paper?
- What are some possible problems that can cause a monitor to display improper color?
- What is color shift and how do you correct it?
- What role does the codec play in audio and video playback?

### **Time**

About 30 minutes

## Section 9.6: Networking

### Preparation

In this section students will learn tips for troubleshooting network and modem problems. Common problems are presented with suggestions on how to solve each problem. Also presented, is an overview of how to interpret the status of the link and status lights on a network card.

#### A+ Core Hardware Objectives:

- 2.1 Recognize common problems associated with each module and their symptoms, and identify steps to isolate and troubleshoot the problems. Given a problem situation, interpret the symptoms and infer the most likely cause.

#### Lecture Focus Questions:

- In a network that uses a hub, what devices can you use to reduce network congestion?
- You have a network that uses BNC connectors. What happens if one of these were to become disconnected?
- What is indicated by a flashing status light on a network card?
- How would your troubleshooting differ if only one device was having trouble accessing the network compared to if all devices were having problems?
- How would you troubleshoot a dial-up connection if the remote computer answers but you were unable to establish the connection?
- What might cause a dial-up connection to be constantly disconnected?

### Time

About 20 minutes