

Tools of the Trade



Inside the Electrician's Toolbox

SHOPWARE

Instructor's Guide

Introduction

This Teacher's Guide provides information to help you get the most out of *Inside the Electrician's Toolbox*, part of the *Tools of the Trade* series. The contents of this guide will allow you to prepare your students before they use the program, assist them as they navigate through the program, and present follow-up activities to reinforce the program's key learning points.

Tools of the Trade is a 6-part series of programs that present inventories of the most common and most basic tools used in specific trades. Each program opens the trade's "toolbox" so students can delve into its basic tools and materials, including their purpose and proper usage. Students will view brief demonstrations of rudimentary tasks with the tools, and gain an understanding of safety precautions, code concerns, and industry tips, if applicable.

Inside the Electrician's Toolbox is a 27-minute video targeted to students (vocational students, in particular) in grades 9-12. Its content is appropriate to such curriculum areas as Technology Education, Trade, and Industrial Education. In addition, the information presented in *Tools of the Trade* could also be presented in vocational/technical schools or "Do it Yourself" adult education courses.

The *Tools of the Trade* series consists of the following titles:

- *Inside the Plumber's Toolbox*
- *Inside the Carpenter's Toolbox*
- *Inside the Mason's Toolbox*
- *Inside the Welder's Toolbox*
- *Inside the Automotive Technician's Toolbox*
- *Inside the Electrician's Toolbox*

Learning Objectives

After watching this video program, students will be able to demonstrate an understanding of the following core concepts corresponding to the NCCER Basic Electrician's Competencies:

- Safety
- Electrical Theory I & II
- Electrical Test Equipment
- National Electrical Codes
- Raceways and Boxes
- Conductors
- Blueprints
- Wiring: Residential and Commercial

Educational Standards

This program correlates with the following standards:

- The competency standards for Core Introductory Craft Skills from the National Center for Construction Education & Research (NCCER);
 - The NOCTI/SkillsUSA Examination Standards;
 - The standards for Basic Skills (Mathematics) and Thinking Skills (Visualization) from the Secretary's Commission on Achieving Necessary Skills (SCANS);
 - The standards of Essential Knowledge and Skills for Trade and Skills for Career Orientation, High School, for the State of Texas;
 - The standards of Essential Knowledge and Skills for Trade and Industrial Education—Construction-Maintenance Systems, High School, for the State of Texas;
 - The standards of Technology Education—Tools, Resources, and Technological Processes, for the State of New York.
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- Standard 2.0 Career Cluster: Architecture and Construction Careers in designing, planning, managing, building and maintaining the built environment. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
 - Standard 16.0 Career Cluster: Transportation, Distribution and Logistics Planning, management, and movement of people, materials, and goods by road, pipeline, air, rail and water and related professional and technical support services such as transportation infrastructure planning and management, logistics services, mobile equipment and facility maintenance. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research)
 - BASIC SAFETY (MODULE 00101-00). The student is able to identify the responsibilities and personal characteristics of a professional craftsman; explain the role that safety plays in the construction crafts; describe what job-site safety means; explain the appropriate safety precautions around common job-site hazards; demonstrate the use and care of appropriate personal protective equipment; follow safe procedures for lifting heavy objects; describe safe behavior on and around ladders and scaffolds; explain the importance of the HazCom (Hazard Communication Standard) requirement and MSDSs (Material Safety Data Sheets); describe fire prevention and fire fighting techniques; and define safe work procedures around electrical hazards. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
 - INTRODUCTION TO CONSTRUCTION MATH (MODULE 00102-00). The student is able to add, subtract, multiply, and divide whole numbers, with and without a calculator; use a standard ruler and a metric ruler to measure; add, subtract, multiply, and divide fractions; add, subtract, multiply, and divide decimals, with and without a calculator; convert decimals to percents and percents to decimals; convert fractions to decimals and decimals to fractions; explain what the metric system is and how it is important in the construction trade; recognize and use metric units of length, weight, volume, and temperature; recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
 - INTRODUCTION TO HAND TOOLS (MODULE 00103-00). The student is able to recognize and identify some of the basic hand tools used in the construction trade; use these tools safely; describe the basic procedures for taking care of these tools. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)

- **INTRODUCTION TO POWER TOOLS (MODULE 00104-00).** The student is able to identify commonly used power tools of the construction trade; use power tools safely; and explain how to maintain power tools properly. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
- **INTRODUCTION TO BLUEPRINTS (MODULE 00105-00).** The student is able to recognize and identify basic blueprint terms, components, and symbols; relate information on blueprints to actual locations on the print; recognize different classifications of drawings; and interpret and use drawing dimensions. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
- **COMMUNICATION SKILLS (MODULE 00107-04).** The student is able to demonstrate the ability to understand information and instructions that are presented in both written and verbal form; and demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
- **EMPLOYABILITY SKILLS (MODULE 00108-04).** The student is able to explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry; demonstrate critical thinking skills and the ability to solve problems using those skills; demonstrate knowledge of computer systems and explain common uses for computers in the construction industry; demonstrate effective relationship skills with teammates and supervisors, exhibit the ability to work on a team, and demonstrate appropriate leadership skills; and be aware of workplace issues such as sexual harassment, stress, and substance abuse. (Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.)
- **Standard:** The student shows an acceptable level of competency that includes demonstrating safe use and knowledge of the following tools and carpentry processes for final certification: hand tools, power tools, blueprints and specifications, building materials and fasteners, measuring and layout operations, foundations, rough framing, exterior finish, interior finish, basic mathematics, and interior system installation. (General Carpentry Competency Standards for the 2015 Certification Examination from NOCTI/SkillsUSA.)
- **Standard:** The student analyzes the effect of personal interest and aptitudes upon educational and career planning, and knows how to locate, analyze, and apply career information. (Texas State Standards: Essential Knowledge and Skills for Trade and Skills for Career Orientation, High School.)
- **Standard:** The student applies technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs. The student: uses a variety of materials and energy sources to construct things; understands the importance of safety and ease of use in selecting tools and resources for a specific purpose; and develops basic skills in the use of hand tools. (New York State Standards on Technology Education: Tools, Resources, and Technological Processes.)

National English Language Arts Standards

The activities in this Teacher's Guide were created in compliance with the following National Standards for the English Language Arts from the National Council of Teachers of English.

- Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

(Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English, Copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.)

National Technology Standards

The activities in this Teacher's Guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project.

- Students demonstrate a sound understanding of the nature and operation of technology systems.
- Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
- Students use technology tools to enhance learning, increase productivity, and promote creativity.
- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Students employ technology in the development of strategies for solving problems in the real world. (The National Education Technology Standards reprinted with permission from the International Society of Technology Education.)

- Standard Number: N.SCANS.1.3. The student is able to: use numbers, fractions, and percentages to solve problems; use tables, graphs, and charts; use computers to enter, retrieve, change, and communicate numerical information. (Secretary's Commission on Achieving Necessary Skills [SCANS] Basic Skills [Mathematics])
- Standard Number: N.SCANS.1.17. The student is able to: imagine building, object or system by looking at a blueprint or drawing. (Secretary's Commission on Achieving Necessary Skills [SCANS] Thinking Skills [Visualization])

Program Summary

Given the wide range of trades in the world today, the *Tools of the Trade* series is a welcome addition to the Shopware brand. Its overview and demonstration of the basic tools used in each trade help lay the foundation of understanding for the trades, and pique student interest in developing "do it yourself" practical knowledge that can also lead to "electrician" as a possible career choice.

Inside the Electrician's Toolbox provides an introductory level overview of the electrical system, highlighting the materials and tools used in electrical work, and emphasizing important safety precautions to consider when on-the-job. The program provides key demonstrations of a wide array of tools used during various electrical tasks, and concludes by highlighting resources that are available to those interested in becoming electricians.

Main Topics

Topic 1: Introduction

The program's host, Alan Pratt, takes the viewer on a brief tour of the electrical system, tracing how power gets from the utility company to the home.

Topic 2: Electrical Work Materials

This topic sheds light on the various wires and cables that carry the current to the myriad of boxes, receptacles, and switches in a typical electrical system.

Topic 3: Safety

Beginning with a run-down of the safety organizations that directly impact electrical work, the host goes through a very important list of safety precautions to follow when on the job.

Topic 4: Electrical Work Tools

There's no better way to gain an understanding of the tools used in electrical work than to see them in action. Key electrician tasks are highlighted, including planning a job, running cables, testing various points in the electrical system, wiring a box, and performing finish work.

Topic 5: The Future

The program concludes with some resources that are available for students who want to learn more about career options for electricians.

Fast Facts

- Most outlets for normal household use in consumer homes are 125V 15A straight-blade receptacles, designated as NEMA (National Electrical Manufacturers' Association) 5-15.
- Think an "electrician" by any other name is not the same? Think again. An electrician can also be known as: Journeyman Electrician; Inside Wireman; Maintenance Electrician; Protective-Signal Repairer; Water Transportation or Construction Electrician; Protective-Signal Installer; Street-Light Servicer; Neon-Sign Servicer; Ship-Boat Manufacturing Electrician; or Residential Wireman.
- The number of electrons passing a given point is called an ampere, or amp. But it can also be expressed as the number of coulombs per second going past that given point. Thus, one amp equates to one coul/sec.
- Thomas Edison not only started the first electric company in 1879 and opened the first power plant for consumer use in 1882, but was the father of invention for over 2,000 new products, including many electrical devices such as meters and switches, fuses, and sockets.
- Transformers allow electricity to be carried efficiently over long distances. They were invented by William Stanley, who in the 1880s created an induction coil that created AC (alternating current) electricity out of DC (direct current) electricity. His company was later purchased by General Electric in 1903.
- The word "circuit" comes from a Latin word meaning "to go around in a circle." Electricity travels in the circle of a closed loop, but when the circuit is "open," the continuous loop is broken and electrons cannot move, so electricity cannot power a device. When you turn on a lamp, a tiny wire in the light bulb closes to complete the circuit and permits electricity to flow through it.
- Did you know you could be using the same electricity that your grandparents did? 1937 was the last year in which any new electricity was generated in the U.S. Ever since then, the same electricity has been continuing in a loop to and from consumers.
- Old test tools should be replaced with new ones, because the latest test tools contain additional safety features that didn't exist as recently as 10 years ago.
- Don't be one of the estimated 58 people who die each week as a result of electric shock. Use an equipment bonding jumper—more commonly known as a grounding pigtail—to ground your device. A grounding pigtail is wrapped in green insulation and comes with a pre-attached grounding screw and a pre-crimped fork connection for easy connection to the device.
- The job outlook looks good for electricians. Electrical devices and wiring will always need to be installed, maintained, and repaired. Electricians will be in high demand not only for new computer and telecommunication installations, but also upgrading and updating older homes and facilities to comply with new electrical codes, and to take advantage of new technologies for their "smart homes."

Vocabulary Terms

2-part circuit detector: A testing tool that allows you to identify the circuit of a receptacle.

4-level voltage tester: A tool that tests for the presence of power, which wire is hot, and whether there is a grounding conductor.

ampacity: Amperage capacity.

amperage: Unit of measure denoting how much current a conductor is carrying. Represented by the letter "I," for intensity of current flow.

arc fault circuit interrupter (or AFCI): An electrical device designed to protect against fires caused by arcing faults in the home electrical wiring. It is required for bedrooms to help prevent fires.

armored cable (AC): Also referred to as BX, it is a cable of wires wrapped in a steel jacket; it has no ground wire since a bonding strip in the metal sheathing does the grounding.

backstabbing: Inserting wires into holes at the back of a device to access and connect to push-in terminals.

box: A connection point for joining wires either with each other or with devices. Depending on the shape, contents, and cover, a box can be used as an electric outlet receptacle box, a switch box, or a junction box.

branch circuits: The conductors between the final overcurrent devices and the outlets or appliances.

cable ripper: A tool with a cutting blade that slits the outer covering of non-metallic sheathed cables.

CAT-5 cables: A type of cable used to power telephones and computer networking.

chisel: A tool used for semi-fine work such as making notches.

circuit breaker: An automatic switch that stops the flow of electric current in a suddenly overloaded or otherwise abnormally stressed electric system. When a circuit overloads, a pair of metal contacts break. Unlike a fuse, the breaker only needs to be physically reset; it doesn't have to be replaced.

circuit plan (wiring plan): A written chart that identifies the location and purpose of each circuit.

conductor: Anything that passes electricity from one point to another. Electrical wires and power lines are conductors.

conduit: Used instead of cables in residential areas where mechanical damage could occur, and in factories and commercial settings, this type of cable must be run before wires are fished through them from box to box in electrical work.

continuity: The state of being whole, unbroken, formed by a complete circuit of properly connected grounding conductors.

continuity tester: A tool that tests fuses, switches, and sockets for interruptions in the path of a current while the power is off.

crown molding: Molding used to cover any interior angle.

demand factor: A percentage used to calculate how much power will be needed in a building at any one time.

dikes: A name for lineman's pliers, side-cutting pliers, wire strippers, or wire cutters.

drywall knife: Also called a rock knife or utility knife, it is a knife that is used by drywall hangers to cut drywall.

drywall saw: A short, stout handsaw used to make long, straight cuts in drywall panels.

dynamic electricity: Also known as electrical current, it is the uniform motion of electrons through a conductor.

fish tape: A tool used to pull wires through spaces and cable systems in electrical work.

fixed appliance: An appliance that is fastened at a specific location, such as a dishwasher.

fuse: A protective device for electric circuits, containing a wire designed to melt and open the circuit under abnormally high electric loads.

GFCI receptacle analyzer: A tool that tests both GFCI and regular receptacles for electrical faults, and whether the receptacle is properly polarized and grounded.

ground fault: When something or someone provides an unintentional path between a source of electrical current and the ground, e.g., when a faulty electrical appliance is touched. Ground faults can also cause fires.

ground fault circuit interrupter (GFCI): A device that detects a ground fault and shuts off power to that circuit in a fraction of a second.

ground rod: A buried rod attached to the grounding conductor to transfer any errant current that could otherwise lead to (and kill) someone.

ground wire: A wire—either a bare copper wire or a wire wrapped in green insulation—that carries any stray current safely to the ground.

grounded: Connected to the earth or to something such as a water pipe that conducts electricity to the earth.

grounded conductor: A system or circuit conductor that is intentionally grounded, usually a bare copper wire or a wire wrapped in black insulation.

grounding conductor: A device that creates two uninterrupted metal pathways back to the ground in an electrical system.

grounding pigtail: A 6" copper wire, usually wrapped in green insulation, used for connecting to wires and grounding the device to which it is attached.

hand-bender: A tool used to bend thin or small electrical conduit by hand.

hot conductor: A wire usually wrapped in red or black that carries current in an electrical system.

kilowatt: One thousand watts.

kilowatt-hours: A unit of measure used by the electric company to measure how much electricity has been consumed. It equates to the number of kilowatts used multiplied by the number of hours of usage.

knob-and-tube wiring: Wires used in some houses that were built before 1950, covered in rubberized cloth with no additional insulation.

laser level (laser line level): A tool that combines a spirit level and/or pendulum with a laser to indicate a leveled line against a surface.

lead wire: The amount of wire left stripped (usually about 6") at an electrical box when wiring an electrical system.

main disconnect: A safety device that shuts off power to the entire electrical system in case of emergency.

multi-tester: A tool that tests for 2 things: electrical voltages and continuity.

National Electric Code (NEC): The code that regulates all electrical work, including but not limited to lighting requirements, the number of receptacles per square foot, grounding issues, circuit sizes, and required wire gauges.

neutral conductor: A wire wrapped in white or gray that carries the return current in an electrical system.

notching: An alternative to drilling when running cable, it is a process in which notches are cut out of joists and studs so that the insulation of wires run through them is not damaged.

ohm: The unit of electrical resistance or impedance in a wire; one ohm equals one volt per ampere.

Ohm's Law: A law that implies that the smaller the wire, the greater the resistance.

pigtailing: A process in which multiple wires are spliced together before connecting to the terminal. A 6" wire pigtail is stripped on each end, used to connect one end to a terminal and the other end to the circuit wires, secured with a wire nut.

pry bar: A tool used to lever or pry stone or heavy objects.

receptacle: A device in an electrical box used to connect equipment—such as a lamp—to the electrical system.

resistance: Measured in ohms, it is a measure of the degree to which an object opposes an electric current through it.

right-angle drill: A drill used for cutting right angles in studs and joists for running cables in an electrical system.

service drop (aerial service): Electrical power source routed overhead.

service entrance: The point where electrical service enters the residence beginning at the utility transformer and ending at the main disconnect.

service head: In a service drop installation, the point where conductors bring power from the transformer to the building. It is usually outside of a building, and higher than the building walls. Also called the "weather head."

service lateral: Electrical power source routed underground, run along the foundation and up through the conduit to the service meter.

service meter: A device that measures the amount of total electricity used in the dwelling.

service panel: Often called a fuse box or breaker box, it houses either fuses or circuit breakers, which shut off automatically when a circuit shorts, or shut off manually when electrical repairs need to be made.

service raceway: Any pipe or conduit through which electrical service wires are run.

sidewiring: A process in which wires are connected to side terminal screws in an electrical device.

snap line: A chalked string used in the building trades to make a straight line on a vertical surface.

spade bit: An inexpensive drill bit, suitable for general use, in the shape of a spade.

splicing: The joining of electrical wires.

squares: Tools used to lay out or test right angles, with two arms at 90 degrees to each other.

static electricity: Unmoving, stationary accumulated charge formed by either an excess or deficiency of electrons in an object.

switch: A device that, when on, makes a circuit, or when off, breaks the circuit in an electrical system.

UL-listed: Equipment or materials included in a list published by UL, whose listing states either that the equipment or material meets appropriate designated standards or that it has been tested and found suitable for use in a specified manner.

Underwriters Laboratories (UL): An independent product safety testing and certification organization.

voltage: A unit of measure denoting the force, or pressure, that moves current through a conductor. Represented by the letter "E," for electromotive force.

voltage detector: A tool that senses power, but does not need to touch bare wire or a terminal to give a reading. It can sense current right through insulation.

wattage: A unit of measure denoting amount of usable power. Represented by the letter "P," for power.

wire nut: A twist-on wire connector used to mechanically join multiple wires.

wiring: A single strand of drawn metal that has a conductor to hold electrons loosely so the current can pass through, and an insulator to hold the electrons tightly so the current can't pass through to the outside.

Pre-Program Discussion Questions

1. What is electricity? How does it get from the utility company to your home?
2. What five basic steps do you think occur in a basic electrical job?
3. Have you or has anyone in your family ever tried to replace a switch? If so, was the task successful? What problems, if any, were encountered? Was the job performed safely, or do you think there were additional safety measures that could have been taken?
4. Does anyone know what a circuit map is? Does your home have one?
5. Why are there different wire sizes, and various kinds of switches and receptacles? What do you think the most common is of each in most households?

Post-Program Discussion Questions

1. What are volts, amps, and watts? How do they relate to each other?
2. What are conductivity, resistance, and ohms? How do they relate to each other? What is Ohm's Law?
3. Explain the process that occurs when a lightbulb illuminates the room after being turned on by a switch. How does the process differ when there are two switches in the room to control the light?
4. Do you think it is safer to be an electrician today than it was 30 years ago? Why or why not? What safety measures must an electrician employ on the job?
5. What regulations can you remember from the program that must be followed to comply with code?

Individual Student Projects

- Does your home have overhead or underground electrical service? Use or borrow a still or video camera that shows how electricity gets into your home. Create a slideshow or video presentation to show your class.
- What size wires and cables do you have in your home? What amperage/voltage? What kinds of receptacles and switches are used? Do you have safety devices installed? Are there any areas where safety devices should be installed? Explain, and if possible, take pictures to support your research.
- Begin by reviewing all safety measures when dealing with electricity and service panels. Then, ensuring that you follow all safety precautions, open up your service panel. Do you have fuses or circuits? Draw a circuit map for your home. Are you overloaded? What recommendations can you make for your own home?

Group Activities

- Utilizing the tools mentioned in the program, perform the following wiring tasks/methods:
 - Wire a switch in the middle of a circuit, then one at the end of a circuit.
 - Practice sidewiring, then backstabbing.
 - Practice splicing and pigtailling.
- Discuss the differences between each pair of tasks, which method was preferable, and why.

- Divide into small groups and research the latest innovations in “Smart Home” technology. Then, using that research and your imagination, design your electrical dream home and create its corresponding circuit map. Be very detailed about the kind of wiring and devices used, and don’t forget to include climate control, security, communications, and—most importantly—safety elements to protect your investment!
- After reviewing the safety procedures for working with circuits and wiring, divide into small groups and practice using the following testing tools on circuits/wires:
 - voltage detector
 - GFCI receptacle analyzer
 - continuity tester
 - multi-tester (analog and digital)
 - 2-part circuit detector

Internet Activities

- Using the Internet and the library, research the evolution of electrical tools, devices, wiring, and innovations since 1920. Create a presentation that shows the timeline of how electrical work has changed and improved, supporting your findings with resources, pictures, and relevant facts.
- Research conduit and BX cable; then write a paper that explains the types and uses of each, and the proper way to cut and install both types.
- Create a poster that depicts your “Top 10 List” of the following:
 - Wire sizes, capacities, and uses
 - Types of boxes
 - Types of switches
 - Types of receptacles
 - Safety considerations when performing electrical workDecorate the poster with relevant magazine photos or graphics.

Assessment Questions

- Q1:** Electricity coming from overhead wires goes through three wires in the service _____. They are spliced to the service _____ and enter the service _____ (sometimes called the weather head) through the service _____ to the service _____, which monitors and records how much electricity is being consumed. If electricity is coming through underground cables, the three wires are called the service _____, and are run along the foundation and up through the service _____ to the service _____.
- Q2:** The movement of electrons is called _____. The force of these electrons moving along the current is called _____, and the number of electrons moving past a given point in one second is labeled _____.
- Q3:** Match each wire conductor color with its corresponding description.
- a) black b) gray c) green d) red e) white
- 1) Electricity flows through a hot conductor marked in _____ or _____ to receptacles, switches, and fixtures.
 - 2) Electricity returns to the service panel through a neutral conductor, colored in _____ or _____.
 - 3) To prevent electrocution from a short or overloaded circuit, a bare copper or _____-wrapped ground wire carries any stray current safely to the ground.
- Q4:** Which of the following is a correct statement about safety features built into or added to an electrical system? (Select all that apply.)
- a) The main disconnect shuts off power to the entire electrical system in case of emergency.
 - b) The grounding conductor creates one unique metal pathway back to the ground via a buried ground rod to transfer any errant current that could otherwise lead to (and kill) someone.
 - c) Ground fault circuit interrupter (or GFCI) receptacles prevent shock by detecting a ground fault and shutting off power to that circuit in a split-second in wet areas.
 - d) Arc fault circuit interrupters (or AFCIs) help prevent against fires in bedrooms.
- Q5:** If a microwave has 120 volts, and 20 amps in its 14-gauge wire, how many kilowatts of power does it use in 1 hour?
- a) 2,400 b) 24 c) 2.4 d) .24 e) 10
- Q6:** Select the true statement:
- a) Code dictates that a receptacle must be installed every 4 feet, so a 4-ft cord can be plugged in anywhere along a wall.
 - b) Code dictates that a receptacle must be installed every 6 feet, so a 6-ft cord can be plugged in anywhere along a wall.
 - c) Code dictates that a receptacle must be installed every 8 feet, so a 4-ft cord can be plugged in anywhere along a wall.
 - d) Code dictates that a receptacle must be installed every 12 feet, so a 6-ft cord can be plugged in anywhere along a wall.
- Q7:** Which of the following is a correct statement? (Select all that apply.)
- a) The NEC estimates that 50 milliamps (ma) is the safe upper limit of exposure to electricity.
 - b) Use a fiberglass or wood ladder that is marked "nonconductive"—never a metal one.
 - c) If you have shut off the main circuit breaker, regardless of whether or not the meter has been removed, the panel is safe to touch.
 - d) Wood- or plastic-covered tools are best for electrical work.
 - e) A permit is required for replacing existing devices with new ones.

Q8: Match each testing tool with its corresponding description.

- a) 2-part circuit detector
- b) continuity tester
- c) multi-tester
- d) voltage detector
 - 1) Tests for current right through insulation.
 - 2) Tests fuses, switches, and sockets for interruptions in the path of a current while the power is OFF.
 - 3) Tests for electrical voltages and continuity.
 - 4) Tests which circuit a receptacle is on.

Q9: Match each term with its corresponding description.

- a) conductor
- b) insulator
- c) lead wire
- d) pigtail
 - 1) Holds the electrons loosely so the current can pass through it.
 - 2) Holds the electrons tightly so the current can't go through it.
 - 3) A 6" wire stripped on each end, used to connect one end to a terminal and the other end to the circuit wires, secured with a wire nut.
 - 4) 6" of stripped wire left at a box for wiring the device.

Q10: True or False: Since plastic boxes do not conduct electricity, they are only grounded at the end of a circuit with a grounding pigtail that is tightly connected to the receptacle's grounding screw.

Assessment Questions Answer Key

Q1: Electricity coming from overhead wires goes through three wires in the service _____. They are spliced to the service _____ and enter the service _____ (sometimes called the weather head) through the service _____ to the service _____, which monitors and records how much electricity is being consumed. If electricity is coming through underground cables, the three wires are called the service _____, and are run along the foundation and up through the service _____ to the service _____.

A1: *Electricity coming from overhead wires goes through three wires in the service **drop**. They are spliced to the service **conductors** and enter the service **head** (sometimes called the weather head) through the service **conduit** to the service **meter**, which monitors and records how much electricity is being consumed. If electricity is coming through underground cables, the three wires are called the service **lateral**, and are run along the foundation and up through the service **conduit** to the service **meter**.*

Q2: The movement of electrons is called _____. The force of these electrons moving along the current is called _____, and the number of electrons moving past a given point in one second is labeled _____.

A2: *The movement of electrons is called **electricity**. The force of these electrons moving along the current is called **volts**, and the number of electrons moving past a given point in one second is labeled **amperes**.*

Q3: Match each wire conductor color with its corresponding description.

a) black b) gray c) green d) red e) white

- 1) Electricity flows through a hot conductor marked in _____ or _____ to receptacles, switches, and fixtures.
- 2) Electricity returns to the service panel through a neutral conductor, colored in _____ or _____.
- 3) To prevent electrocution from a short or overloaded circuit, a bare copper or _____-wrapped ground wire carries any stray current safely to the ground.

A3: *The correct answers are 1 a and d; 2 b and e; 3 c.*

Q4: Which of the following is a correct statement about safety features built into or added to an electrical system? (Select all that apply.)

- a) The main disconnect shuts off power to the entire electrical system in case of emergency.
- b) The grounding conductor creates one unique metal pathway back to the ground via a buried ground rod to transfer any errant current that could otherwise lead to (and kill) someone.
- c) Ground-fault circuit-interrupter (or GFCI) receptacles prevent shock by detecting a ground-fault and shutting off power to that circuit in a split-second in wet areas.
- d) Arc fault circuit interrupters (or AFCIs) help prevent against fires in bedrooms.

A4: *The correct answers are (a), (c), and (d). (b) is incorrect because the grounding conductor actually provides two uninterrupted metal pathways back to the ground—one via a buried ground rod and the other via the cold-water supply pipe near the service panel to transfer any errant current that could otherwise lead to (and kill) someone.*

Q5: If a microwave has 120 volts, and 20 amps in its 14-gauge wire, how many kilowatts of power does it use in 1 hour?

a) 2,400 b) 24 c) 2.4 d) .24 e) 10

A5: *The correct answer is (c).*

Q6: Select the true statement:

- a) Code dictates that a receptacle must be installed every 4 feet, so a 4-ft cord can be plugged in anywhere along a wall.
- b) Code dictates that a receptacle must be installed every 6 feet, so a 6-ft cord can be plugged in anywhere along a wall.
- c) Code dictates that a receptacle must be installed every 8 feet, so a 4-ft cord can be plugged in anywhere along a wall.
- d) Code dictates that a receptacle must be installed every 12 feet, so a 6-ft cord can be plugged in anywhere along a wall.

A6: *The correct answer is (d).*

Q7: Which of the following is a correct statement? (Select all that apply.)

- a) The NEC estimates that 50 milliamps (ma) is the safe upper limit of exposure to electricity.
- b) Use a fiberglass or wood ladder that is marked "nonconductive"—never a metal one.
- c) If you have shut off the main circuit breaker, regardless of whether or not the meter has been removed, the panel is safe to touch.
- d) Wood- or plastic-covered tools are best for electrical work.
- e) A permit is required for replacing existing devices with new ones.

A7: *The only correct answer is (b). (a) is not correct because the upper limit is much lower—only 5 ma, not 50. (c) is not correct because even if you have shut off the main circuit breaker, regardless of whether or not the meter has been removed, the panel is still hot. (d) is not correct because you should always choose double-insulated rubber-covered tools instead of wood- or plastic-covered ones. And (e) is not correct because a permit is required for electrical work except when replacing existing devices with new ones.*

Q8: Match each testing tool with its corresponding description.

- a) 2-part circuit detector
 - b) continuity tester
 - c) multi-tester
 - d) voltage detector
- 1) Tests for current right through insulation.
 - 2) Tests fuses, switches, and sockets for interruptions in the path of a current while the power is OFF.
 - 3) Tests for electrical voltages and continuity.
 - 4) Tests which circuit a receptacle is on.

A8: *The correct answers are 1d; 2b; 3c; 4a.*

Q9: Match each term with its corresponding description.

- a) conductor
 - b) insulator
 - c) lead wire
 - d) pigtail
- 1) Holds the electrons loosely so the current can pass through it.
 - 2) Holds the electrons tightly so the current can't go through it.
 - 3) A 6" wire stripped on each end, used to connect one end to a terminal and the other end to the circuit wires, secured with a wire nut.
 - 4) 6" of stripped wire left at a box for wiring the device.

A9: *The correct answers are 1a; 2b; 3d; 4c.*

Q10: True or False: Since plastic boxes do not conduct electricity, they are only grounded at the end of a circuit with a grounding pigtail that is tightly connected to the receptacle's grounding screw.

A10: *This statement is true.*

Additional Resources

Associated Builders and Contractors

www.abc.org

American Design Drafting Association (ADDA)

www.adda.org

Associated General Contractors of America (AGC)

www.agc.org

American National Standards Institute (ANSI)

www.ansi.org

U.S. Department of Labor, Bureau of Labor Statistics

www.bls.gov

Electrical Safety Foundation International

www.esfi.org

International Brotherhood of Electrical Workers

www.ibew.org

International Building Code (IBC) of the International Code Council

www.iccsafe.org

Vocational Information Center

www.khake.com

National Electrical Contractors Association

www.necanet.org

National Center for Construction Education and Research (NCCER)

www.nccer.org

National Electrical Code

www.nfpa.org/nec

Occupational Safety & Health Administration (OSHA)

www.osha.gov

SkillsUSA

www.skillsusa.org

Additional Resources at www.films.com

Available from Films Media Group • www.films.com • 1-800-257-5126

Residential Electrical Wiring

- VHS/DVD
- [Preview clip online](#)
- Closed captioned
- Correlates to the National Center for Construction Education and Research standards
- Includes viewable/printable teacher's guide
- Order #32070 (Spanish version Order #36061)

Construction, renovation, rehabbing... To succeed in today's housing market, electricians need to know how to do it all! That's where this outstanding eight-part series comes in. Filled with information on installing, upgrading, and updating residential electrical service, it walks students through all the major processes they'll need to know. The series includes *Wiring Methods; Grounding; GFCIs and AFCIs; Receptacles and Switches; Wiring Light Fixtures; Wiring for Appliances; The Service Entrance; Panelboards*. (16-21 minutes each) © 2004

Electricians

- VHS/DVD
- [Preview clip online](#)
- Correlates to educational standards
- Order #32264

Once your students have learned what the skilled construction trades have to offer, they will want to know more about specific jobs that may interest them. This fast-paced program provides a concise profile of electricians, looking at educational background, apprenticeships, salary, and the work itself. (13 minutes) © 2003

Industrial Electrician

- VHS/DVD
- [Preview clip online](#)
- Correlates to educational standards
- Order #32297

Industrial electricians must be focused, have good manual dexterity, and be able to solve problems creatively. This program describes the tasks of industrial electricians, including laying electrical lines and testing electronic equipment for the automotive, aerospace, medical, and communications sectors. The video also explains the apprenticeship system and spotlights women in the business. (16 minutes) © 2003

Electrical Principles

- VHS/DVD
- [Preview clip online](#)
- Closed captioned
- Correlates to educational standards
- Includes viewable/printable teacher's guide
- Order #35393

This live-action video introduces the basics of electricity. Computer animation adds interest and excitement as the video comes to life in its coverage of atoms, conductors, insulators, free electrons, voltage, current, resistance, magnetism, attraction-repulsion, electromagnets, a simple circuit, and other electrical principles. Ideal for courses in electricity, physics, science, automotive, and technology. (18 minutes) © 2006

Auto Body Repair: Electrical Repairs

- **VHS/DVD**
- **Preview clip online**
- **Closed captioned**
- **Correlates to educational standards**
- **Includes viewable/printable teacher's guide**
- **Order #32783**

This video looks at common automotive electrical problems. It covers how to use a DVOM to check continuity, voltage, resistance, and amperage; inspect, test, and replace fusible links, circuit breakers, and fuses; and work on batteries and alternators. Don't get a shock—develop a well-grounded knowledge of electricity. Correlates to the standards for the Collision Repair and Refinish Technician Training Certification Program, from the National Institute for Automotive Service Excellence and the National Automotive Technicians Education Foundation. (20 minutes) © 2005

Electrical Safety

- **VHS/DVD**
- **Preview clip online**
- **Closed captioned**
- **Correlates to educational standards**
- **Includes viewable/printable teacher's guide**
- **Order #25284**

Those who work with electricity encounter many hazards, including electric shock and electrical fires. This video details safety procedures for these hazards as well as protection of electrical instruments and solid-state devices. An excellent overview for those who work with electricity and as a general safety video for everyone. (21 minutes)



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